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Latent Classes and Transitions for Brief Alcohol Interventions in Trauma Settings: Clinical and Policy Implications

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Latent Classes and Transitions for Brief Alcohol Interventions in Trauma Settings: Clinical and Policy Implications

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Dedication

This dissertation project is dedicated to Jen, Mia, and Bri. To my wife: Jen, you have been my greatest support during the dissertation and throughout my Ph.D. Without you, I could not have completed this project, my degree, or hope to accomplish any other worthy goal in my life, *thank you.* To my lovely daughters: Mia and Bri, your laughter, smiles, and hugs have brought me great happiness during this process, *thank you girls*. Finally, I gratefully acknowledge the hand of Providence—my family and I have been richly blessed and our burdens have been made light during my time in the Ph.D. program and while completing this dissertation project.

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Latent Classes and Transitions for Brief Alcohol Interventions in Trauma Settings: Clinical and Policy Implications

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Abstract: Those who misuse alcohol in the United States do not regularly seek treatment on their own to reduce use and avoid consequences of misuse. Because of the association between alcohol misuse, alcohol-related risk behaviors, and injury; alcohol misuse in the United States has serious societal and individual repercussions. To alleviate these problems, health care professionals; including doctors, nurses, and social workers; have an opportunity to screen injured patients for alcohol misuse and provide brief interventions. Although some brief intervention research has demonstrated reductions in alcohol misuse and other injury-related behaviors, other evidence indicates that brief alcohol interventions are not equally effective for all injured patients. Moreover, screening and brief alcohol interventions are not reimbursed in most states, leaving providers and medical centers uncompensated for providing services. A possible way to address these challenges is to target intervention services to patients who are most likely to make positive changes. Therefore, this dissertation used mixture modeling to identify subclasses of injured patients based on their past injury-related consequences and risks of alcohol misuse in order to describe which subgroups made the greatest reductions in

drinking in the year following discharge from a Level-1 trauma center. This dissertation also identified which subclasses of patients made the greatest behavioral improvements for injury-related consequences and risks of alcohol misuse during the year following discharge from the trauma center. Patients with profiles that contained high probabilities of multiple consequences and risks and those with histories of alcohol-related accidents and injuries reported some of the largest improvements in drinking and injury-related consequences and risks following discharge. Those classes that made the fewest changes had profiles that consisted of fighting and taking foolish risks while drinking or that consisted of low probabilities of risks or consequences of alcohol misuse. This dissertation provides tentative evidence for targeting intervention services to injured patients. Further research should verify which subclasses of patients are most likely to reduce alcohol misuse and other alcohol-related risk behaviors in order to more effectively target brief alcohol interventions, increase cost savings, and improve the health and behavioral health outcomes for injured patients who misuse alcohol.

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Chapter I: Background and Rationale

INTRODUCTION

The misuse of alcohol results in serious financial, social, and health-related consequences for individuals in the United States (Harwood, 2000; Miller & Hendrie, 2009). Alcohol-related injury is one of the most serious individual consequences of alcohol misuse, and alcohol misuse is the number one cause of injury in the nation (Centers for Disease Control and Prevention [CDC], 2010). Driving after drinking (Field & O'Keefe, 2004) and alcohol-related violence (Macdonald et al., 2005) are major predictors of injury. The majority of individuals who misuse alcohol, nevertheless, do not seek care or treatment in order to reduce or eliminate their use (Substance Abuse and Mental Health Services Administration [SAMHSA], 2009). As a result of the prevalence of alcohol-related injury in the nation along with the absence of treatment seeking among those who misuse, health care professionals; such as doctors, nurses, social workers, and psychologists; have the opportunity to help injured patients reduce risk-use and avoid subsequent injury by screening for alcohol misuse and providing brief interventions (American College of Surgeons, n.d.; Havard, Shakeshaft, & Sanson-Fisher, 2008; Higgins-Biddle, Hungerford, & Cates-Wessel, 2009; Nilsen et al., 2008).

Brief interventions for injured patients have shown efficacy in reducing alcohol misuse and other alcohol-related risk behaviors (Field & Caetano, 2010; Gentilello et al., 1999; Longabaugh et al., 2001; Monti et al., 1999; Schermer, Moyers, Miller, & Bloomfield, 2006). The American College of Surgeons (ACS) requires that all Level-1 trauma centers screen for alcohol misuse and provide brief interventions to those who are

positive (American College of Surgeons, 2006). It is not clear, however, within the research literature that brief alcohol interventions are equally effective and beneficial for all injured patients (Field, Baird, Saitz, Caetano, & Monti, 2010; Nilsen, et al., 2008). In addition to the shortcomings for SBI efficacy, SBI is a behavioral health service that is not reimbursed in most states (Behavioral Healthcare, 2008; Fornili & Alemi, 2007). Therefore, providers and health care systems are generally not compensated for screening patients and delivering brief alcohol interventions.

Given that: (1) alcohol misuse and alcohol-related risk behaviors frequently predict injury, (2) brief alcohol interventions are helpful to some but not all patients, and (3) screening for alcohol misuse and providing brief interventions is a required but largely uncompensated service, the purpose of this dissertation was to improve the knowledge-base for health care providers regarding which brief intervention recipients make the greatest drinking and risk behavior improvements following discharge from a Level-1 trauma center. With a clearer understanding of which intervention recipients are making the greatest improvements, providers possibly could target brief intervention services to those who are most likely to change and develop and deliver alternative services to those who are less likely to improve.

To supply providers with the necessary information for targeting brief interventions to those patients who are most likely reduce alcohol use and alcohol-related risk behaviors, this dissertation carried out three mixture model analyses of patients who misused alcohol, suffered traumatic injuries, were admitted to a Level-1 trauma center for care, received SBI, and were subsequently discharged. The first of these mixture models

was a latent class analysis (LCA) that identified if subclasses among brief intervention recipients existed based on past injury-related risks and consequences of alcohol misuse. Further, this LCA also sought to identify which subclasses of intervention recipients experienced the largest reductions in alcohol use. The second of the mixture models was a latent transition analysis (LTA) that sought to identify if individuals within subclasses reduced risk behaviors and avoided consequences of alcohol misuse in the year following their discharge from a trauma center. The final analysis of this dissertation replicated analysis one (i.e., the LCA) in order to substantiate its findings and improve the generalizability of the results. Understanding which injured patients experience the greatest improvements following injury, brief intervention, and discharge from Level-1 trauma care settings is critical in order to effectively and efficiently utilize scarce behavioral health services, decrease alcohol misuse, and reduce future injury.

Overview of Dissertation Format

This dissertation is presented in a three paper format, which includes five chapters. The first chapter of this dissertation gives an overview of the problem, discusses screening and brief alcohol intervention, and outlines each of the three papers that constitute chapters two through four. The backgrounds, methods, results, and conclusions of the LCA, LTA, and LCA replication are presented in chapters two, three, and four. The final chapter provides a summary of the purpose, goals, and findings of this dissertation. This final chapter also discusses the research, direct-practice, and macro-practice implications of this project for the brief intervention field and allied health care professions.

STATEMENT OF THE PROBLEM

Epidemiology of Alcohol Misuse and Injury

Alcohol-related services in the United States cost more than $185 billion each year (Harwood, 2000). These costs include criminal justice repercussions, lost earnings, and individual health consequences, including injury and accidents (Miller & Hendrie, 2009). Risky drinking is a major predictor of emergency room utilization (Cherpitel & Ye, 2008) and is the primary risk factor for injury in the nation (CDC, 2010). In all levels of trauma centers (Level-1, most acute care, to Level-4, least acute care), approximately 15 percent of patients who are screened (with about half of all patients being screened in total) test positive for alcohol use—with 10 percent of patients having a blood alcohol level above 0.08 (National Trauma Data Bank, 2011). For Level-1 trauma centers that employ efforts to screen all patients, 40 (Field, Caetano, Harris, Frankowski, & Roudsari, 2010) to 50 (Gentilello, et al., 1999) percent of patients admitted for injury care are intoxicated.

Alcohol-related injuries result in up to a four times higher rate of hospital admission and require a higher level of medical care than non-alcohol-related injuries (Shults, Elder, Hungerford, Strife, & Ryan, 2009). Specifically, the costs of treating alcohol-related injuries are approximately 20 percent more than other injuries in light of the higher acuity of care needed, which includes services such as catheterization of patients and additional diagnostic tests (O'Keeffe, Shafi, Sperry, & Gentilello, 2009). Alcohol-related injury not only occurs among those who habitually and consistently drink at high levels (e.g., individuals with alcohol use disorders), but research also

demonstrates that individuals at highest risk for alcohol-related injuries are those who drink on fewer occasions at high-levels (Cherpitel et al., 2010; Gmel et al., 2006), such as binge drinkers. Urban traumatic injury is a chronic and recurrent problem (Brooke, Efron, Chang, Haut, & Cornwell, 2006; Morrissey, Byrd, & Deitch, 1991; Sims et al., 1989; Smith, Fry, Morabito, & Organ, 1992), with up to a 44 percent recidivism rate (Sims, et al., 1989).

In addition to risky drinking and injury, driving motorized vehicles after drinking is a specific alcohol-related behavior that is a major contributor to fatal and non-fatal injury. Excessive alcohol consumption not only impairs drivers' motor control, judgment, and alertness (CDC, 2011), but those who drink and drive have a four times higher rate of not always wearing seatbelts (Bergen & Rudd, 2011). The Centers for Disease Control and Prevention (CDC) estimates that among adults (≥18 years) in the United States during 2010 there were 112 million episodes of driving after individuals believed they had too much to drink (Bergen & Rudd, 2011). In the same year, binge drinkers accounted for approximately 85 percent of reported drinking and driving episodes (Bergen & Rudd, 2011).

The National Highway Traffic Safety Administration (NHTSA) reports that nearly one-third of all traffic fatalities involve drivers who are intoxicated beyond legal limits (National Highway Traffic Safety Administration, 2008b, 2009a). Moreover, driving while under the influence is among the driving-related risk behaviors that more than double an individual's risk for sustaining an injury (Field & O'Keefe, 2004). Nearly one-third of motor vehicle crashes involving alcohol result in injury (National Highway

Traffic Safety Administration, 2008b), and alcohol misuse-related car crashes are a significant predictor of cases admitted to trauma centers (McLellan et al., 1990; Stoduto et al., 1993).

Alcohol use and related violence are also primary predictors of injury across the United States. Violent offenses, such as homicide, assault, and sexual assault are often perpetrated by individuals who have been drinking or perpetrated on individuals who have been drinking (Collins & Messerschmidt, 1993). In 2008, nearly 20 percent of victims of simple assaults and more than 20 percent of victims of aggravated assaults perceived that their assailant was under the influence of alcohol when perpetrating the offense (Bureau of Justice Statistics, 2010). Binge drinking, in particular, is common among individuals who perpetrate violent offenses that result in injury (Brewer & Swahn, 2005).

Alcohol-related violence and injury are also leading causes of subsequent treatment in emergency (Cherpitel, 1993) and trauma settings (Field, Claassen, & O'Keefe, 2001; Field & O'Keefe, 2004). In a cross-national study of six countries, researchers reported that individuals with a blood alcohol content greater than 0.08 were three times more likely to sustain an intentional (violent) injury than an accidental injury (Macdonald, et al., 2005). Furthermore, in a study of the Trauma Registry of the American College of Surgeons, researchers found that patients who had positive blood alcohol levels were roughly three times more likely to experience an injury resulting from an assault and were more than two times as likely to be injured as a result of being

stabbed than those who had negative blood alcohol levels (Blondell, Looney, Krieg, & Spain, 2002).

Unmet Alcohol Treatment Needs

As a consequence of the serious repercussions associated with alcohol misuse, actions to assist individuals eliminate misuse must be taken. Some individuals decrease their alcohol misuse through their own efforts (Dawson, Grant, Stinson, & Chou, 2006), and others utilize community resources, such as 12-Step programs or recovery centers. The majority of individuals with alcohol disorders, however, do not perceive their drinking as problematic and do not receive any help (SAMHSA, 2009). The difference between the number of individuals who need treatment for alcohol problems compared to those who actually seek and receive care is substantial. According to Substance Abuse and Mental Health Services Administration (SAMHSA), in 2008, of the19 million individuals in the United States who needed treatment for alcohol problems, 17.4 million did not receive care (SAMHSA, 2009). Thus, roughly nine of every ten individuals who needed treatment did not receive it.

In addition to the number of individuals who do not seek treatment in the general population, minorities have disproportionate levels of misuse and face particular challenges in obtaining alcohol treatment services. Data from the 2009 National Survey on Drug Use and Health (National Survey on Drug Use and Health, 2009) show binge alcohol use as highest among Hispanics compared to all other races and/or ethnicities. Furthermore, while non-Hispanic Whites are more likely to develop alcohol dependence in their lifetime than people of other races and/or ethnicities, Hispanic and Black

Americans are more likely than Whites to have recurrent or persistent dependence (Chartier & Caetano, 2010), with Mexican and Puerto Rican men having the highest rates of abuse and dependence compared to Cuban and South and Central American men (Caetano, Ramisetty-Mikler, & Rodriguez, 2008). Hispanic and Black drinkers are also more likely than Whites to report negative social consequences due to of drinking; such as physical or verbal fights; accidents, and workplace, legal, and health problems (Mulia, Ye, Greenfield, & Zemore, 2009).

Hispanics and Blacks are also less likely to utilize alcohol treatment services, with Hispanics indicating higher levels of economic and logistical reasons compared to Whites for not seeking specialty treatment services (Schmidt, Ye, Greenfield, & Bond, 2007). In a recent study of those who misuse alcohol and sustain a traumatic injury, Hispanics were noted to have higher levels of alcohol dependence than Whites without having sought previous treatment (Field, Cochran, & Caetano, In press). Dependent Hispanic and Black treatment seekers have lower rates of health insurance. Therefore, it may not be surprising that these individuals rely less on third party payment for treatment services than their White counterparts (Schmidt & Weisner, 2005) and generally must seek treatment services that are provided at a low or no cost to them. However, racial and ethnic minorities are less likely than Whites to become involved in no cost mutual-help groups (Arroyo, Westerberg, & Tonigan, 1998; Schmidt, Greenfield, & Mulia, 2006), as has been demonstrated by lower rates of attendance of Alcoholics Anonymous (AA) among Hispanics (Arroyo, et al., 1998). The hypothesized reasons for lower attendance

of programs such as AA include Hispanics' reliance on family for support and beliefs that programs like AA do not work (Arroyo, et al., 1998).

Whether it is individuals in general or a minority group in particular, most who misuse alcohol do not receive specialty care for these problems and persist in patterns of misuse, which results in costly burdens for society and serious individual problems, including traumatic injury. However, due to the association (and often times causal relationship) between alcohol misuse and behaviors leading to injury, many individuals with alcohol problems end up seeking care for injuries. When this happens, depending on the severity or extent of the alcohol misuse problem, health care providers have the potential to screen, deliver interventions, or make referrals to treatment (Madras et al., 2009). In 2008, 1.7 million individuals received substance abuse services in health care settings (SAMHSA, 2009), a promising start for getting individuals the help they need.

SBI Overview and Empirics

Emergency and trauma settings have demonstrated their vital importance as locations to screen and provide intervention services for individuals who misuse alcohol. Screening and brief intervention (SBI) for injured patients who misuse alcohol in emergency and trauma care settings have been tested for more than 20 years (Nilsen et al., 2008). When SBI was first conceptualized, providers were concerned about identifying and addressing substance abuse problems in health care settings because provider patient time is highly compressed and adding on additional services would not be feasible (Babor, Ritson, & Hodgson, 1986). For this reason, designing and employing screening and intervention services that were *brief* has been paramount. While this

dissertation will not examine specific aspects of the mechanics of SBI, a brief overview of methods and approaches used for SBI may be helpful.

Screening injured patients for alcohol misuse generally falls into two categories: biological screening instruments and psychometric screening instruments. Biological instruments include blood alcohol concentration analyses that test the alcohol content present in one's blood (Medline Plus, 2009). One advantage of these measures is their ability to objectively quantify an individual's level of intoxication. However, a weakness is that alcohol can only be detected in the blood three to ten hours after use (Medline Plus, 2009). Therefore, if blood is not drawn and tested within a relatively short period of time following an injury, patients who misuse alcohol may go undetected.

A solution to the short window of time available for blood alcohol draws has been the development of a number of psychometric instruments for assessing alcohol misuse. An additional advantage to psychometric instruments is that their administration is simpler and more time efficient for providers and thus more cost effective for health care organizations. These instruments, in the most basic sense, are questionnaires that ask patients a list of questions intended to identify drinking behaviors, patterns, and related events that indicate different levels of alcohol misuse. Although a number of credible and valuable instruments exist, only a few of the most well-known are mentioned here.

The Michigan Alcohol Screening Test (MAST) is a 25-item measure for assessing alcohol misuse and was one of the first brief alcohol screening questionnaires developed (Selzer, 1971). Other brief measures for screening alcohol misuse include the CAGE, a four-item instrument (Mayfield, McLeod, & Hall, 1974), and the Alcohol Use Disorders

Identification Test (AUDIT), a ten-item instrument (Babor, Higgins-Biddle, Saunders, & Monterio, 2001). Each of these measures can be administered rapidly, in less than ten minutes (National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2003). Despite the brevity with which instruments like the MAST, CAGE, and AUDIT can be administered, researchers and clinicians in health care settings saw a need to establish briefer screening instrument for alcohol problems, known as "single-item screeners." Single-item instruments are comprised of one alcohol misuse question that is predictive of more serious misuse patterns (Canagasaby & Vinson, 2005; Reed et al., 2005; Seale et al., 2006; Smith, Schmidt, Allensworth-Davies, & Saitz, 2009; Williams & Vinsion, 2001). However, if a patient answers positively to a single item instrument, it is recommended that multi-item measures follow (NIAAA, 2007) to avoid false positive screening results.

Patients identified as having misused alcohol are eligible candidates for a brief intervention. Research has shown that brief intervention delivery to injured patients can be executed in an equally effective manner by health professions, such as physicians, nurses, and social workers (Murray, 2010). Despite the consistency in SBI delivery by health professions, the composition of brief interventions themselves varies widely (Dunn, DeRoo, & Rivara, 2001; Nilsen, et al., 2008). Attempts have been made to establish standard guidelines/protocols for brief interventions, such as the FRAMES (Feedback, Responsibility, Advice to change, Menu of alternative choices, Empathy, and Self-efficacy) model (Miller, Zweben, DiClemente, & Rychtarik, 1995) or the Brief Negotiated Interview (D'Onofrio et al., 2005; Bazargan-Hejazi et al., 2005). However,

brief interventions in health care settings (including emergency and trauma care settings) can best be described as falling along a continuum of types of interventions, ranging from prescriptive to those based more in motivational interviewing (Cochran & Thompson, 2012).

On the prescriptive end of the continuum, interventions are more directive and less patient centered, focusing on prescribing what patients should do to improve alcohol misuse (NIAAA, 2007). In contrast, interventions based on motivational interviewing are more guiding than directive in style and are aimed at evoking from patients the need for change (Rollnick et al., 2008; Field et al., 2005; Dunn & Ostafin, 2005). Practice behaviors that are illustrative of motivational interviewing-based brief interventions include open-ended questions, examination of ambivalence, and exploration of pros and cons of change (Longabaugh et al., 2001; Miller et al., 1995). Though this dissertation will not examine the specifics and variability in what characterizes SBI, the variability in what constitutes a brief intervention has been cited as a possible issue for gauging outcomes (Dunn, et al., 2001; Nilsen, et al., 2008).

Clinical trials that have delivered SBI to injured patients have shown a number of positive outcomes. These findings include reductions in alcohol use (Antti-Poika, Karaharju, Roine, & Salaspuro, 1988; Bazargan-Hejazi et al., 2005; Gentilello, et al., 1999; Haque et al., 2003; Neumann et al., 2006), decreased future alcohol-related injuries (Gentilello, et al., 1999; Longabaugh, et al., 2001), increased levels of seeking alcohol treatment (Neumann, et al., 2006; Runge, Garrison, Hall, Waller, & Shen, 2002), and reductions in other alcohol-related risk behaviors, such as drinking and driving (Monti, et

al., 1999) and drinking and driving-related arrests (Schermer, et al., 2006). In addition to the general effectiveness of SBIs, specific findings illuminate the efficacy of this service for subgroups of study participants. One study identified ethnicity as a moderator of outcomes (Field, et al., 2010). By using a multilevel modeling approach to examine if minorities responded better than other races to SBI, researchers found that being Hispanic significantly interacted with the intervention to better predict reduced drinking outcomes (Field, et al., 2010). These enhanced effects have been shown to have some relation to matching Hispanic interventionists to Hispanic patients (Field & Caetano, 2010).

Risk taking has also been associated with alcohol-related injuries (Coghlan & Macdonald, 2010; Field, et al., 2001) and has been shown to be amenable to change and significantly impacted by SBI. For example, Lin et al. (2010) found that a composite risk score based on several risk factors (including amount of alcohol use, binge drinking, driving after drinking, and someone being concerned about the participant's drinking) was significantly related to reduced drinking at three- and 12-month follow-ups in patients receiving SBI, relative to a control condition. Other categories of variables have also been linked with alcohol reduction outcomes. Alcohol-related violence is a leading cause of injury treatment in emergency (Cherpitel, 1993) and trauma settings (Field, et al., 2001; Field & O'Keefe, 2004). Individuals involved in violent offenses who received a brief alcohol intervention reported significant reductions in subsequent injuries (Watt, Shepherd, & Newcombe, 2008).

Another subgroup that has been responsive to SBI is patients who attribute their injury to their alcohol use. Alcohol-related traumatic injures often result in what is termed

"the teachable moment" (Blondell, et al., 2002; Vaca & Winn, 2007). One explanation for SBI's success in reducing alcohol use and injury-related risk behaviors is that SBIs may capitalize on this teachable moment by highlighting the relationship between alcohol use, risk behaviors, and injury. Researchers have found that causal attribution moderates study outcomes (Barnett et al., 2010; Walton et al., 2008). That is, brief interventions have shown to be more efficacious in reducing drinking over time for those persons who believe their drinking was the cause of their accident (Barnett, et al., 2010; Walton, et al., 2008).

In addition to the main outcomes and moderator effects identified in SBI trials for injured persons, cost-effectiveness studies have shown a $3.81 savings for every dollar spent on brief alcohol interventions. If brief alcohol interventions were offered to all eligible patients in the United States, the annual estimated savings would be $1.82 billion in health care costs (Gentilello, Ebel, Wickizer, Salkever, & Rivara, 2005). Furthermore, this empirical evidence for the potential financial benefits of screening and brief alcohol interventions for injured patients has resulted in the establishment of policy-level supports to promote service delivery. The American College of Surgeons mandates that Level-1 and -2 trauma centers screen patients for alcohol misuse and that Level-1 centers provide brief alcohol interventions (American College of Surgeons, 2006). In connection with this mandate, billing codes for SBI reimbursement have been created, and the Centers for Medicare and Medicaid Services have consistently budgeted funds for the delivery of SBI services (Behavioral Healthcare, 2008; Fornili & Alemi, 2007). In

general, SBI for alcohol demonstrates promise for helping injured individuals who misuse alcohol.

Challenges for SBI: Empirics and Policy

Despite the evidence and policy supports for SBI, there are empirical indications that brief alcohol interventions compared to control conditions have not been clearly efficacious in producing positive changes among injured patients who misuse alcohol. Specifically, a number of randomized clinical trials with injured individuals who misuse alcohol have failed to demonstrate significant brief intervention treatment effects for drinking reductions at follow-up (Daeppen et al., 2007; Dauer, Rubio, Coris, & Josep Marti, 2006; Dauer et al., 2003; Dent, Weiland, Phillips, & Lee, 2008; Soderstrom et al., 2007). Other clinical trials of SBI for injured patients have not shown changes in alcohol-related adverse driving events (Crawford et al., 2004; D'Onofrio et al., 2008; Kunz, French, & Bazargan-Hejazi, 2004; Sommers et al., 2006), and one study was unable to show significant differences for injury recidivism for patients who received an intervention compared to those in the control conditions (Roudsari, Caetano, Frankowski, & Field, 2009). Furthermore, meta-analyses and systematic reviews of SBI for injured populations have also reported somewhat unclear and mixed results for SBI's efficacy among injured patients (Daeppen, 2008; Havard, et al., 2008; Nilsen, et al., 2008).

In attempts to understand why some studies demonstrate successful outcomes while others have not, multivariate analyses have been used to identify which patient-centered factors may influence or confound study success. Researchers have analyzed multiple predictors of change, and results have proven contradictory. For instance, Monti

and colleagues (2009) reported that injured patients with higher levels of baseline drinking frequency had greater reductions in alcohol intake compared to those with lower drinking levels, and Field and Caetano (2010) found that trauma patients who were dependent on alcohol reported greater improvements following the receipt of brief interventions. Others have also observed drinking severity as a moderator affecting intervention effectiveness, but in the opposite direction than the studies by Monti et al. and Field et al. These other studies have found that individuals with high levels of alcohol use fail to demonstrate significant change (reduced drinking) after receiving SBIs (Dunn, 2003; Dunn & Ostafin, 2005; National Institutes of Health [NIH], 1995). In Gentilello et al.'s (1999) seminal trauma department SBI study, patients with higher scores on a standardized screening instrument did not benefit from the intervention while those with lower scores did (Gentilello, et al., 1999).

A second example of conflicting SBI outcomes is from analyses of gender differences. Broadly speaking, men outnumber women in nearly every class of alcohol misuse by approximately double—including alcohol dependence, alcohol abuse (NIAAA, 2006) and binge drinking (SAMHSA, 2008). These gender differences for severity of alcohol use between men and women also emerged to some extent in SBI trials—but not in a consistent manner. Specifically, in SBI studies from the mid-1990s, Reinhardt and colleagues (2008) observe women seemed to benefit more from brief interventions than men. In contrast, Gentilello and colleagues (1999) reported that men benefited more than women from the brief intervention delivered in their study. Furthermore, in sex specific

SBI studies (i.e., studies that recruit only men or only women), one gender has not reported consistent success over the other (Reinhardt et al, 2008).

A final example of ambiguity with respect to which injured patient populations respond well to SBI comes from studies that have examined research trials in aggregate. As mentioned above, researchers conducting systematic (Nilsen, et al., 2008) and meta-analytic (Havard, et al., 2008) studies to examine SBI trials have found inconsistencies in study outcomes. Some suggest that differences in the way the studies were conducted may have contributed to the variation in study results (Daeppen, 2008; Havard, et al., 2008); while others have hypothesized that the influence of subgroups is responsible to some degree for these mixed results (Field, Baird, et al., 2010).

In addition to these limitations for SBI outcomes, gaps also exist within macro-level efforts encouraging the use of SBI for injured patients. Though SBI is now a standard of care in trauma centers with billing codes and federal funding allocated, 80 percent of U.S. states have not taken action to make SBI billing possible (Behavioral Healthcare, 2008; Fornili & Alemi, 2007). Since SBI carries with it expenses of screening materials/lab equipment, lab services, and/or providers' time, the vast majority of trauma care providers are left with the challenge of complying with the unfunded mandate of screening all injured patients for alcohol misuse and delivering interventions. While such an unfunded mandate might be sustainable in health care settings where profit margins are adequate, trauma centers are often financially unprofitable and rely heavily on governmental sources to remain solvent (Bazzoli, Kang, Hasnain-Wynia, & Lindrooth, 2005; Selzer et al., 2001; Shen, Hsia, & Kuzma, 2009).

Another possible macro-level challenge in delivering SBI, particularly to injured patients, is the Uniform Accident and Sickness Policy Provision Law (i.e., UPPL). Roughly half of the states in the U.S. have a UPPL statute (Cochran, 2010), which allows health insurance companies to deny reimbursement for the cost of health care services provided to patients who have suffered injuries related to alcohol or drug intoxication (Chezem, 2004). Therefore, screenings and interventions could constitute a vehicle by which insurers can document that patients' injuries may be a consequence of their alcohol use. While some insurers claim that this law is antiquated and is not used to deny payment for health care costs for patients injured related to drugs or alcohol (Texas House of Representatives, 2007), national surveys of trauma surgeons (Gentilello et al., 2005) and social workers practicing in health care settings (Cochran & Davis, 2012) report that these professionals have been aware of denials of reimbursement.

If empirical results had shown SBI to be consistently beneficial for all injured patients who misuse alcohol, not being reimbursed for SBI and possibly forfeiting insurance reimbursement for other health care services could be viewed as acceptable risks outweighed by the benefits of possible patient improvement. However, given the mixed empirical and policy supports for SBI, broad implementation based on general efficacy may be unwarranted.

Current Knowledge, Practice, and Steps to Move Forward

One possible approach to build on the strengths that exist for alcohol SBI and address the limitations that exist for SBI research and policy support could be to target brief intervention services to those who are most likely to make positive changes

following the intervention. Health care service prioritization and strategic delivery is relatively common in medical settings. For instance, in emergency care settings, while all patients are eventually seen by staff, those triaged as needing the most immediate care are seen first. Another example of a targeted approach comes from cancer treatment. Patients with certain types of cancers receive the treatments to which their particular cancer will most likely respond (National Cancer Institute, n.d.). Similarly, it may be that certain types of individuals or profiles of individual behaviors may characterize a better response to brief alcohol interventions compared to patients with different characteristics. To explore taking such an approach with injured patients who screen positive for alcohol misuse, knowing who responds best to brief alcohol interventions may be critical.

SBI research literature lacks clarity, however, regarding which injured individuals respond best to these interventions (Field, Baird, et al., 2010; Miller et al., 2006). Therefore, this dissertation will contribute to the public health services field of brief alcohol interventions for injured patients by enhancing the understanding of which injured patients improve behaviors to the greatest extent following an injury, admission, SBI service delivery, and trauma center discharge. This knowledge can then catalyze further research concerning which injured patients experience the most change after receiving SBI. Knowing which patients respond best to brief alcohol interventions in trauma centers would allow policymakers, health care administrators, and clinicians to make any needed shifts in clinical practice of prioritizing which patients must receive interventions before discharge. Further, such information would also assist policymakers, administrators, and clinicians to identify which patients may be better served through

other types of alcohol intervention services. Brief alcohol intervention services delivered in such a fashion have the capacity to maximize impact of treatment for patient populations and avoid delivering more costly interventions to those who are unlikely to respond.

The current practice for brief alcohol intervention delivery in Level-1 trauma centers involves behavioral health and/or medical clinicians screening injured patients for alcohol misuse using biological and/or brief standardized instruments. Following screening, providers generally deliver a one-time 15 to 30 minute brief intervention to injured patients who screen positive for alcohol misuse. Individuals who receive care in urban trauma centers often have histories of injury, and their injuries frequently result from risky alcohol use, drunk driving, and alcohol-related violence. Research indicates that response to SBI could be influenced by gender differences, ethnic differences (i.e., Hispanics are more likely than non-Hispanic patients to reduce drinking following SBI), alcohol use severity, and individual attribution of injuries to alcohol use.

What is not clear is how these individual factors of drinking and driving, alcohol-related violence, history of injury, gender, ethnicity, levels of alcohol use severity, risky drinking, and causal attribution come together and impact one another to influence brief intervention outcomes. Therefore, this dissertation has addressed three research aims:

1. This dissertation identified subclasses of injured patients who received a brief alcohol intervention in a Level-1 trauma center and which of those classes experienced the greatest improvements. Latent class analysis (LCA) was used to identify probabilistic patient profiles or “classes” based on past injury-related risk behaviors. Demographic

characteristics, injury history, and patient beliefs about the relation of their alcohol use and the injury event were used to determine individuals' membership in the defined classes. Level of improvement was measured by which injury-related risk class experienced the greatest reductions in alcohol use.

2. This dissertation analyzed the longitudinal injury-related risk behavior profile changes patients experienced in the year following the receipt of a brief alcohol intervention and discharge from a Level-1 trauma center. Latent transition analysis (LTA) was used to model the transitions that patients experienced from their baseline injury-related risk subclasses into other subclasses across time.
3. This dissertation partially replicated the LCA model from research aim one using a second dataset from a similar brief alcohol intervention trial conducted in another separate Level-1 trauma center. The purpose of replicating findings from research aim one using a separate dataset was to determine whether the established LCA model could be supported in a second population. The replication of research studies is one way to examine the objectivity, accuracy, and generalizability of results.

BRIEF SUMMARY OF METHODS

The methods for these three research aims are reported in full for this dissertation in three separate papers (comprising chapters two through four). These papers will be submitted to peer-reviewed academic journals. A brief summary of the methods used in each paper follows.

Paper One: Research Aim One

Data from the Multidisciplinary Approach to Reducing Injury and Alcohol (MARIA) project (P.I.: Caetano, R., NIAAA, R01 013824), a clinical trial conducted in Level-1 trauma department in Dallas, Texas, was used to conduct the analyses for paper one. Injured adult patients who reported alcohol misuse were recruited to participate in the MARIA project. This dataset represents the largest SBI randomized clinical trial dataset collected in the United States and is comprised of 1,493 cases. It contains baseline, six-, and 12-month alcohol use and alcohol risk information on 668 White, 288 Black, and 537 Hispanic patients. Follow up rates in this study have been reported elsewhere and are comparable to other brief intervention clinical trials (Field, et al., 2010). Three main articles have been published using these data. The first paper showed significant reductions in alcohol use for Hispanic patients who received a brief intervention compared to other race/ethnicities (Field, et al., 2010). The second paper demonstrated that alcohol dependent individuals who received the brief intervention experienced significant reductions in drinking compared to patients who drank at different levels (Field & Caetano, 2010). The third paper showed no significant differences for injury recidivism between those who received the intervention and those that did not (Roudsari, et al., 2009).

To add to these current publications, in this dissertation study, LCA was employed to identify latent classes based on the item-response probabilities (Collins & Lanza, 2010) using data collected at baseline in the MARIA study. The latent factor estimated was based on variables representing lifetime injury-related consequences and

risks of alcohol misuse that occurred prior to the current injury. The variables selected for this latent factor were items from the Short Inventory of Problems (SIP; Center on Alcoholism, Substance Abuse, and Addictions [CASAA], 1994) +6. The additional six items (+6) in this measure come from the Drinker Inventory of Consequences (CASAA, 1995). Fit indices and likelihood ratio tests recommended and commonly reported in the mixture modeling research literature (Nylund, Asparouhov, & Muthén, 2007) were used to determine the numbers of latent classes. Classification statistics were used to assess the quality of the established classes. The covariates of race, gender, history of injury care, and patients' perception of the relationship between alcohol misuse and the current injury were also estimated along with distal drinking outcomes. All analyses were conducted in Mplus 6 (Muthén & Muthén, 2010a) and IBM SPSS 19 (International Business Machines [IBM], 2011).

Paper Two: Research Aim Two

The second paper in this dissertation assessed transitions across time for patients from baseline latent classes into other classes at subsequent time points. Developing an LTA model involves including cross-sectional LCA models into a longitudinal latent transition analysis (LTA) model to represent change and transitions across time between latent classes. Given the use of the cross-sectional models, the LCA model established in paper one of this dissertation was adapted and expanded for use in the longitudinal model.

The same injury-related consequences and alcohol use risk indicators used for the cross-sectional model in paper one were employed in the LTA. However, in paper one,

these items were based on lifetime questions. For the LTA, time-one indicators were limited to capture behaviors one year before the current injury and hospital admission. The same injury-related consequences and risks of alcohol misuse indicators were used in the second LTA time period and report patients' behaviors in the year following discharge from the trauma center. Together, the time-one and time-two models that encapsulate behaviors from the year before and the year after discharge create a more straightforward analysis and interpretation of the transitions because of fewer parameters to estimate and the equal time periods within the model. Fit indices and likelihood ratio tests recommended and reported in the mixture modeling research literature (Nylund, et al., 2007) were used to determine the numbers of latent classes. All latent classes and transitions were estimated using Mplus 6 (Muthén & Muthén, 2010a).

Paper Three: Research Aim Three

The third dissertation paper determined if the findings from the LCA in research aim one could be replicated. The purpose of replicating findings from the MARIA LCA was to determine whether the established model could be supported using a similar but separate dataset. Replication of research studies is one way to examine the objectivity, accuracy, and generalizability of results (Bowling, 2009; Rubin & Babbie, 2008). The replication of findings increases confidence that the identified model is applicable to traumatically injured populations beyond those studied in the MARIA data.

The replication of research aim one was carried out using data from Project Delta (P.I.: Dischinger, P., NIAAA, R01 AA09050-04A2). Project Delta was a SBI clinical trial conducted at the R. Adams Cowley Shock Trauma Center at the University of

Maryland Medical Center, a Level-1 trauma department (Soderstrom, et al., 2007). This dataset is comprised of information from 497 individuals who suffered a traumatic injury and reported alcohol misuse. Two papers have been published using this data set. The first showed significant reductions in drinking for both the experimental and control groups post brief intervention but no significant treatment effects (Soderstrom, et al., 2007). The second paper showed decreases in drinking were unaffected by self-reported impulsivity and depression (Ryb et al., 2011).

The Project Delta dataset and the MARIA project dataset contain similar variables. In particular, the SIP (CASAA, 1994, 1995) +6 was used to assess the injury-related consequences and risks of alcohol misuse. In the LCA replication, fit indices and likelihood ratio tests were used to determine the numbers of latent classes (Nylund, et al., 2007). Classification statistics were also used to assess the quality of the established classes. The covariates of race, gender, history of injury care, and patients' perception of the relationship between alcohol misuse and the current injury were also estimated along with distal drinking outcomes. All analyses were conducted in Mplus 6 (Muthén & Muthén, 2010a) and IBM SPSS 19 (IBM, 2011a).

Data Considerations

Only data from the experimental groups in both the MARIA (n=737) and Delta (n=250) studies were used in this dissertation because this study's intent was to identify latent classes (or profiles) among intervention recipients based on injury-related consequences of alcohol misuse. Upon establishing latent classes among intervention recipients, this dissertation sought to provide a descriptive analysis of the variability in

drinking improvements among those classes. This dissertation's intent was to also provide a descriptive longitudinal analysis of transitions among behavioral profiles based on injury-related risks consequence of alcohol misuse for those participants who received SBI. Main effects for treatment have not been examined because those effects are beyond the scope of this project and have been reported previously (Field & Caetano, 2010; Field, et al., 2010; Roudsari, et al., 2009; Ryb, et al., 2011; Soderstrom, et al., 2007).

In addition to the descriptive purpose of this dissertation, the application of mixture modeling to SBI outcomes is new within the field, and the application of mixture modeling to clinical trials is also an emerging approach. Therefore, this dissertation project sought to lay the groundwork for further LCA and LTA analyses of SBI clinical trial data. As such, solid first steps in the application of mixtures to SBI are to determine (1) if there are indeed heterogeneous classes among a homogenous patient grouping (i.e., injured individuals who report alcohol misuse and subsequently receive SBI) and (2) whether those subclasses have different change experiences with respect to post discharge alcohol use and behavioral profiles. If such foundational evidence can be successfully established, future models with greater potential for causal inferences could possibly be hypothesized, constructed, and tested.

CHAPTER SUMMARY/CONCLUSION

Alcohol misuse in the United States is a serious problem that results in injury. Doctors, nurses, social workers, and other health care professionals have the opportunity to screen and provide brief intervention services aimed at reducing alcohol misuse, risk behaviors, and future injury. Despite some research evidence and policies that support the

delivery of these interventions, it is not clear within the literature that brief alcohol interventions are equally efficacious for all injured patients. Furthermore, the delivery of SBI services is largely unfunded in all health care settings. This dissertation adds to the limited evidence in the health services field with respect to which patients respond best to brief alcohol interventions. A more comprehensive knowledge of which injured patients made the greatest changes following injury and SBI may increase policymakers, health care administrators, and clinicians' ability to make potentially necessary changes to improve medical centers' effectiveness and efficiency in delivering SBI services to injured patients. In more specific terms, this dissertation contributes to the foundational evidence needed to support possibly targeting brief interventions to those patients who will experience the greatest reductions in drinking and other injury-related risk behaviors. This dissertation also suggests that providers consider developing other or delivering less expensive and time consuming intervention services to those who are likely to experience less change.

Chapter II: Injury-Related Consequences of Alcohol Misuse among Injured Patients Who Received SBI for alcohol: A Latent Class Analysis

BACKGROUND

Epidemiology of Alcohol Misuse and Injury

Risky drinking is the primary risk factor for injury in the nation (CDC, 2010). Alcohol-related injuries occur among those who habitually and consistently drink at high levels (e.g. individuals with alcohol use disorders), and individuals who drink on fewer occasions at high-levels (e.g. binge drinkers) are often those at highest risk for alcohol-related injuries (Cherpitel, et al., 2010; Gmel, et al., 2006). Approximately 40 (Field, Caetano, Harris, Frankowski, & Roudsari, 2010) to 50 percent (Gentilello, et al., 1999) of all patients admitted to Level-1 trauma centers are intoxicated. Once discharged, patients who suffered traumatic injuries often experience in re-injury (Brooke, et al., 2006; Morrissey, et al., 1991; Sims, et al., 1989; Smith, et al., 1992), with a recidivism rate of up to 44 percent (Sims, et al., 1989). Motor vehicle crashes are a major source of alcohol-related injury among patients admitted to trauma centers (National Trauma Data Bank, 2011), with nearly one-third of all alcohol-related motor vehicle crashes resulting in injury (National Highway Traffic Safety Administration, 2008b). Alcohol-related violence is also a leading cause of injury treatment in emergency (Cherpitel, 2007; Cunningham et al., 2009) and trauma settings (Field, et al., 2001; Field & O'Keefe, 2004). Violent offenses, such as assault and sexual assault, are often perpetrated by individuals who have been drinking or perpetrated on individuals who have been drinking

(Bureau of Justice Statistics, 2010; Borges, Cherpitel, & Mittleman, 2004; Collins & Messerschmidt, 1993).

Addressing Alcohol-Related Injury

Given the interrelationship between alcohol misuse and behaviors leading to injury, many individuals with alcohol problems receive acute care at emergency and trauma settings. These medical service settings have become vitally important for screening and providing intervention services for individuals who misuse alcohol. Results of screening and brief intervention (SBI) studies for injured patients who misuse alcohol have demonstrated reductions in alcohol use (Antti-Poika, et al., 1988; Bazargan-Hejazi, et al., 2005; Gentilello, et al., 1999; Haque, et al., 2003; Neumann, et al., 2006), decreases in subsequent alcohol-related injuries (Gentilello, et al., 1999; Longabaugh, et al., 2001), increased levels of seeking alcohol treatment (Neumann, et al., 2006; Runge, et al., 2002), and reductions in other alcohol-related risk behaviors, such as drinking and driving (Monti, et al., 1999) and drunk driving arrests (Schermer, et al., 2006). Cost-effectiveness estimates indicate that offering brief alcohol interventions to all eligible patients in the United States would result in an annual savings of $1.82 billion in health care costs (Gentilello, Ebel, et al., 2005).

Despite the evidence for SBI, there are also empirical indications that brief interventions are not effective for all patients. A number of randomized clinical trials with injured individuals who misuse alcohol have failed to demonstrate significant reductions in alcohol use at follow-up compared to control conditions (Daeppen, et al., 2007; Dauer, et al., 2006; Dauer, et al., 2003; Dent, et al., 2008). Similar SBI clinical

trials have also not shown changes in alcohol-related adverse driving events (Crawford, et al., 2004; D'Onofrio, et al., 2008; Kunz, et al., 2004; Sommers, et al., 2006), and one study was unable to demonstrate significant differences for injury recidivism (Roudsari, et al., 2009).

Because of these mixed findings, researchers have sought to understand which subgroups of study participants could be responding to SBIs. For example, Field and colleagues (Field, et al., 2010) used a multilevel modeling approach and found that Hispanics had better drinking outcomes than other races/ethnicities following a brief intervention. Gentilello and colleagues (1999) found that male injury patients responded to a brief intervention delivered in a trauma center while females did not, though females are underrepresented in many studies.

Beyond individual participant characteristics, Mello and colleagues (2005) reported that patients injured in a motor vehicle crash responded more favorably to a brief intervention than did patients who experienced non-motor vehicle crash injuries. Further, Lin et al. (2010) found that a risk score based on several factors (including amount of alcohol use, binge drinking, driving after drinking, and someone being concerned about the participant's drinking) was significantly related to reduced drinking at three- and 12-month follow-ups in patients receiving SBI, relative to a control condition. Other categories of variables, such as violence perpetration, have also been associated with alcohol reduction outcomes in SBI (Watt, et al., 2008). Watt et al. (2008) showed that individuals involved in violent offenses who received a brief alcohol intervention reported significant reductions in subsequent injuries.

Researchers have also found that causal attribution significantly influences study outcomes (Barnett, et al., 2010; Walton, et al., 2008). That is, brief interventions have been more efficacious in reducing drinking over time for those persons who believed their drinking was the cause of their accident. Alcohol-related traumatic injures often result in what is termed "the teachable moment" (Blondell, et al., 2002; Vaca & Winn, 2007). One explanation for the success of SBI in reducing alcohol use and injury-related risk behaviors is that SBIs may capitalize on this teachable moment by highlighting the relationship between alcohol use, risk behaviors, and injury.

STUDY PURPOSE

Putting together the above findings, what is known is that traumatic injury often results from risky alcohol use, drunk driving, and alcohol-related violence, and individuals who sustain injuries are also likely to experience future injuries. Brief interventions delivered to address these alcohol misuse issues have been found to be more helpful in reducing drinking with patients who are Hispanic, men, and who attribute their current injuries to alcohol use. However, it is not clear how these individual factors of drinking and driving, alcohol-related violence, history of seeking care for injury, ethnicity, gender, risky drinking, and causal attribution come together to impact one other to influence alcohol use outcomes. Furthermore, the research literature is not clear regarding whether brief alcohol intervention recipients in general change their drinking behaviors or if subgroups of individuals are primarily responsible for driving observed changes. It is possible that it is these subgroups that are influencing positive outcomes in

some studies and their absence could partially explain null findings in other studies (Field, Baird, et al., 2010).

The purpose of this secondary analysis was to identify whether there are subclasses of injured patients who received a brief alcohol intervention in a Level-1 trauma center that experience greater or lesser changes in alcohol use following admission, intervention, and discharge. Latent class analysis (LCA) was used to identify probabilistic patient profiles or "classes" based on past injury-related consequences of alcohol misuse. The measure used in the current study to capture the combined alcohol use and risk behaviors was the SIP+6 (CASAA, 1994, 1995; Schaus, Sole, McCoy, Mullett, & O'Brien, 2009; Soderstrom, et al., 2007). The strength of the this instrument is its ability to capture both alcohol misuse and consequences as they pertain to seeking injury care—hence the measure's broad and well established use and utility in the brief intervention services and research fields (Dischinger, P., NIAAA, R01 AA09050-04A2; Caetano, R., NIAAA, R01 013824; Field, C., NIAAA, R01 DA026088; Longabaugh, R., NIAAA, 5R01AA09835; Velasquez, M.M. and Field, C., NIDA, 1R01DA026088-01). The use of the SIP+6 is particularly appropriate for the present study because high levels of alcohol use alone do not necessarily predict all injury-related consequences. Since those who have infrequent levels of high use, such as binging, are at higher risk for injury than those who have long-term high levels of misuse (Borges, et al., 2004; Cherpitel, et al., 2010; Gmel, et al., 2006), the SIP+6 captures alcohol use along coupled with those other behaviors that predict injury. In addition to the SIP+6, demographic characteristics, history of injury care, and patient beliefs about the relation of their alcohol use and the

injury event were also used to determine individuals' membership in the defined classes. Finally, benefit from the brief intervention was measured by determining which subgroups experienced the greatest reductions in post-intervention alcohol use.

METHOD

Study Sample

Data from a SBI clinical trial conducted in a Level-1 trauma department was used in this analysis (P.I.: Caetano, R., NIAAA, R01 013824). The consort chart (i.e., the numbers of patients of patients screened, recruited, and that completed follow up), methods of participant recruitment, and description of treatment conditions for this trial have been reported elsewhere (Field & Caetano, 2010; Field, et al., 2010; Roudsari, et al., 2009). Recruitment for this trial study took place in a Dallas, Texas, Level-1 trauma center. Participants were not screened for the study if they were less than 18 years of age, spoke languages other than English or Spanish, or had insufficient contact information to allow for follow up assessment. Patients were also not screened if they were under arrest or in police custody, were actively suicidal or psychotic, were victims of sexual assault, or had a medical condition precluding study involvement. Furthermore, cognitively disoriented or intoxicated patients were monitored by staff to assess eligibility for recruitment. Patients recruited in the study had a clinical indication of intoxication upon admission to the trauma center (but not intoxicated at the time of recruitment), reported drinking six hours before the injury event, reported drinking at or above NIAAA risk levels (NIAAA, 2007), or responded positively on one or more items of the CAGE (Ewing, 1984; Kitchens, 1994). Eligible patients provided signed informed consent to

participate in the study. Study participants were randomized into one of two conditions: treatment as usual (TAU) or brief motivational intervention (BMI). Participants in both conditions were assessed for approximately 30 to 40 minutes at baseline, six, and 12 months. Participants in the BMI and the TAU conditions received the same assessment, which included demographic, substance use, and injury-related risk behavior questions. Following the assessment, participants in the TAU condition were provided with handouts related to alcohol use and misuse by the assessor administering the questionnaire. Patients randomized to receive a BMI met with a study clinician following the assessment. This dataset contains baseline, six-, and 12-month alcohol use and alcohol risk information (N=1,493) for patients admitted for care.

The main outcomes from the original trial found significant reductions in alcohol use among Hispanic participants compared to others (Field, et al., 2010) and for those who were alcohol dependent compared to those who were not dependent (Field & Caetano, 2010). Data from the experimental group only (n=737) was used to conduct the present study. The experimental group only was used because the intent of this project was to identify if patient subclasses based on injury-related consequences and risks of alcohol misuse existed. If so, this study sought to provide a descriptive analysis of the variability in change among the identified subclasses. Therefore, main effects for treatment were not examined in this secondary analysis as those effects were beyond the scope of this project and have been reported previously (Field & Caetano, 2010; Field, et al., 2010; Roudsari, et al., 2009).

Variables

The variables selected for analysis in the present study were items from the Short Inventory of Problems (SIP) +6 (CASAA, 1994); the additional six items added to the standard SIP come from the Drinker Inventory of Consequences (DrInC-2L; CASAA, 1995). The items selected from the SIP+6 are the injury-related consequences of alcohol misuse that have been identified and established in the literature as the specific factors that result in individuals to receiving emergency and trauma care (see Table1; Field & O'Keefe, 2004; Gentilello, et al., 1999; Macdonald, et al., 2005; McLellan, et al., 1990; Schaus, et al., 2009; Soderstrom, et al., 2007; Stoduto, et al., 1993). The covariates selected for inclusion in this LCA model are also factors that have emerged from the literature; including demographic traits (Field, Raul Caetano, et al., 2010; Gentilello, et al., 1999), beliefs about drinking and the current injury (Barnett, et al., 2010; Walton, et al., 2008), and injury treatment history (Brooke, et al., 2006; Morrissey, et al., 1991; Sims, et al., 1989; Smith, et al., 1992; see Table1); that have been found to be characteristic of those who seek care for alcohol-related injuries and have made positive changes in alcohol use following the receipt of brief interventions.

Participant response to the intervention was measured in this project using multiple self-report measures of alcohol use (see Table1). These distal drinking outcome variables were calculated based on quantity and frequency questions (Greenfield, 2000; Midanik, 1994) at baseline, six-, and 12-month follow ups. A standard drink for this project was measured as 12 ounces of beer, five ounces of wine, or 1.5 ounces of distilled spirits (Dawson, 2003). Percent days abstinent (PDA) estimations were based on

individual participants' frequency of drinking. Percent days heavy drinking (PDHD) were calculated by dividing the frequency of having five or more drinks per drinking occasion by participants' drinking frequency. Volume of alcohol use per week was calculated by multiplying quantity of drinks per occasion by frequency of drinking for each week. Maximum amount consumed in one day was measured as a single item asked of all participants (Dawson, 2003; Field & Caetano, 2010; Field, et al., 2010).

Table 1. Observed indicators, covariates, distal outcomes, and time period in which they were included in the LCA model

Observed Indictor	Time Period(s)
I have driven a motor vehicle after having three or more drinks (SIP+6)	Baseline
I have taken foolish risks when I have been drinking (SIP)	Baseline
I have gotten into a physical fight while drinking (SIP+6)	Baseline
I have been arrested for driving under the influence of alcohol (SIP+6)	Baseline
I have had an accident while drinking or intoxicated (SIP)	Baseline
While drinking or intoxicated, I have been physically hurt, injured or burned (SIP+6)	Baseline
While drinking or intoxicated, I have injured someone else (SIP+6)	Baseline
Covariates	**Time Period(s)**
Previous ED/hospital treatment for injury	Baseline
Causal attribution	Baseline
Male	Baseline
Hispanic	Baseline
Black	Baseline
Distal outcomes	**Time Period(s)**
Percent days heavy drinking	Baseline, 6, and 12 months
Percent days abstinent	Baseline, 6, and 12 months
Volume per week	Baseline, 6, and 12 months
Maximum amount consumed per drinking occasion	Baseline, 6, and 12 months

Model Summary

One latent variable was estimated in this LCA. The estimation of this construct determined the classes (or profiles) of individuals who have endorsed like items in the past injury-related consequences and risks of alcohol misuse response set. The direct relationships tested include the parameters from the construct regressed onto the seven observed indicators. Direct effects from the covariates and distal outcomes were also regressed onto the latent construct.

Analyses

LCA was selected as the statistical method for this project because it allowed for the identification of subgroups of individuals (Collins & Lanza, 2010) using a subset of injury-related consequences and risks of alcohol misuse items. LCA is an appropriate method for analyzing patterns within binary and categorical variables (Collins & Lanza, 2010; McCutcheon, 1987; Muthén & Muthén, 2010b). To identify the injury-related consequences and risks profiles of alcohol misuse (called classes in LCA), LCA uses item-response probabilities (Collins & Lanza, 2010) of the selected variables (items from the baseline time point for this project) to identify subgroups of patients. The Akaike Information Criterion (AIC), Adjusted Bayesian Information Criterion (ABIC), the Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (LMRALRT), and Bootstrapped Likelihood Ratio Test (BLRT), (Collins & Lanza, 2010; Muthén & Muthén, 2009; Nylund, et al., 2007) were used to establish the LCA solution with the optimal number of classes. The lowest values of AIC and ABIC were used to indicate the optimum number of classes within the model (Nylund, et al., 2007). Also, one class minus a non-significant

LMRALRT and BLRT value was used in combination with the AIC and ABIC to substantiate the number of classes at each time point. In practical application, this means that the LMRALRT and BLRT values for an increasing number of classes were tested, starting with a two class solution, then three, and so on. The LMRALRT and BLRT output provide a *p*-value for each solution. When the *p*-value for a solution is significant, this indicates that one more class should be tested. Once the LMRALRT and BLRT *p*-values become non-significant, this indicates the previous class with the significant solution ($\leq .05$) is the optimal number of classes (Nylund, et al., 2007). Quality of classification was examined to support the accuracy of classification for subgroups identified. Mplus 6 (Muthén & Muthén, 2010a) was used to carry out the LCA.

Additional influences on class membership were estimated by adding demographic characteristics, causal attribution, and previous injury medical care as covariates to the model (Collins & Lanza, 2010; Lanza, Collins, Lemmon, & Schafer, 2007; Nylund, 2007). Mplus estimates the influence of these covariates using a logistic regression equation and provides parameter estimates, standard errors, and *p*-values. Further, to examine drinking outcomes at the six- and 12-month follow ups for individuals' classes, distal outcomes were also estimated (Nylund, 2007). Post-hoc analyses were performed to examine the effect sizes for changes in drinking levels between follow up time points and whether or not mean differences between follow up drinking levels were significant. To examine the magnitude of the effect sizes between means at follow up time points, Cohen's d statistics were calculated (Cohen, 1988). To examine the significance of differences between means for the drinking outcomes, class

assignments based on most likely class membership were used to carry out Paired Sample T-tests between means at baseline and follow up time points. These analyses were performed in IBM SPSS 19 (IBM, 2011).

RESULTS

A total of 737 individuals (see Table2) who received a brief alcohol intervention in a Level-1 trauma center were included in the analysis. Participants were mostly males (n=630, 85.5%) and had a mean age of 33 years (SD=11.4). The largest racial/ethnic group in the sample was Whites (n=326, 44.2%) followed by Hispanics (n=263, 35.7%) and Blacks (n=148, 20.1%). Most participants had a high school diploma or GED (n=263, 35.7%) or some high school education (n=278, 37.7%). Most participants had experienced unintentional injury (n=582, 79%). Participants drank heavily on 62 percent of drinking occasions (SD=0.03) in the last year and consumed an average volume of 15.47 (SD=22.1) drinks per week. More than a third of participants (n=277, 37.6%) had received previous alcohol treatment.

Table 2. Population demographics and baseline alcohol use

Characteristic		Number	%
Gender	Male	630	85.5%
	Female	107	14.5%
Race/Ethnicity	White	326	44.2%
	Hispanic	263	35.7%
	Black	148	20.1%
Education	Some High School	278	37.7%
	High School Diploma/GED	263	35.7%
	More than High School	196	26.6%
Marital Status	Married/cohabitating	214	29.0%
	Single/never married	329	44.6%
	Separated/divorced/widowed	194	26.3%
Age*		33.4	11.4
Injury Type	Intentional	155	21.0%
	Unintentional	582	79.0%
Prior Alcohol Treatment	No treatment	460	62.4%
	Yes treatment	277	37.6%
Baseline Alcohol Use*	Percent days abstinent	67%	0.3
	Percent days heavy drinking	62%	0.4
	Average volume consumed	15.47	22.1
	Maximum consumed on one occasion	13.89	10.9

*Mean and standard deviation

Using the seven indicators of injury-related consequences of alcohol misuse selected for the LCA model, a five class solution was identified (see Table3). This model was based on the lowest values of the AIC (4950.12) and ABIC (5005.78) along with one class minus a non-significant LMRALRT (p=.02) and BLRT (p<.001). These five classes

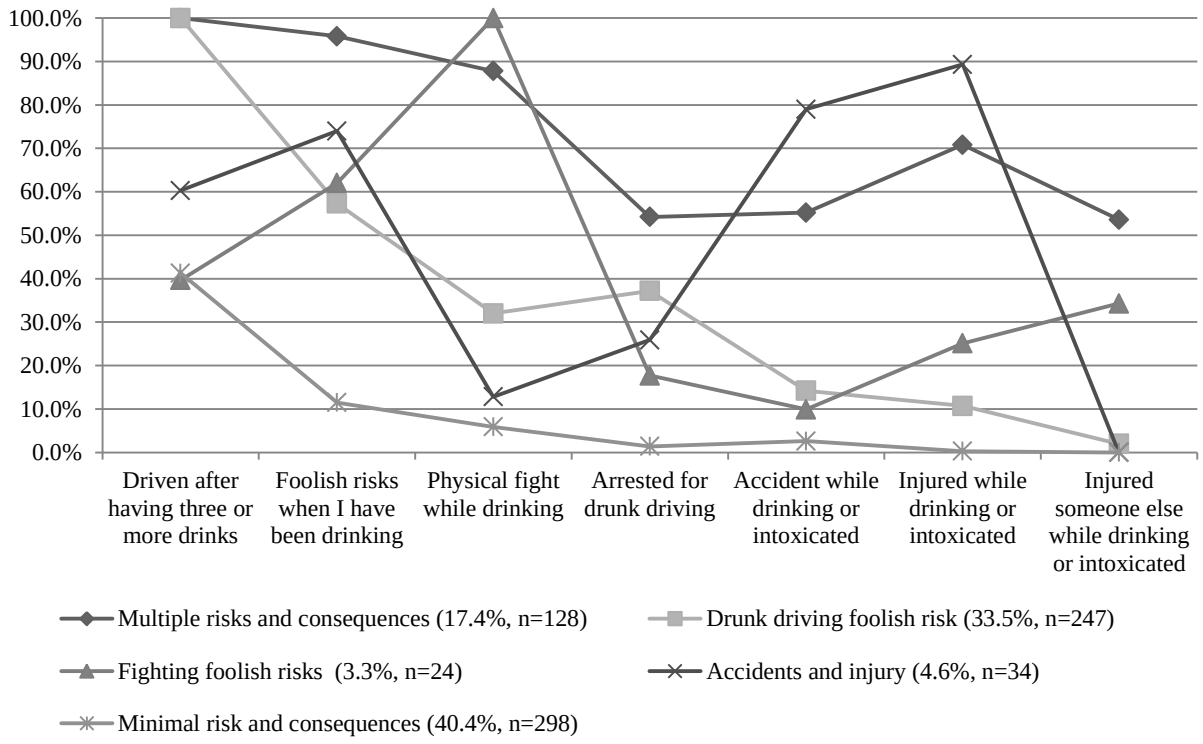
can be described using labels related to the key discriminating dimensions as follows (see Figure 1): (1) *the multiple risks and consequences class* (n=134, 18.1%) endorsed four of the seven items at rates higher than any other class, and the other three items were endorsed at the second highest levels compared to other groups. This group had the highest levels of drinking at baseline (see tables 5-8). The quality of classification for this class was 0.83. (2) All members of *drunk driving and foolish risk class* (n=247, 33.5%) had driven after having three or more drinks. The second highest item endorsement for this class was taking foolish risks (57.3%). This class also had the second highest PDA, and the third highest PDHD, volume consumed, and maximum amount consumed (see Table 5-8). The quality of classification for this class was 0.80. (3) All members of the *fighting and foolish risks class* (n=24, 3.3%) had been in a physical fight when drinking, and the second highest item endorsement for this group was taking foolish risks (62.0%). This class had the third lowest level of PDA, the lowest PDHD, fourth highest volume per week, and the second highest maximum amount consumed at baseline (see tables 5-8). The quality of classification for this class was 0.88. (4) The *accidents and injury class* (n=34; 4.6%) was composed of members who while intoxicated had most often experienced an accident (79%) and suffered an injury (83.9%). This class had the second highest drinking levels, with the exception of maximum consumed for which they had the second lowest amount (see tables 5-8). The quality of classification for this class was 0.75. (5) The *minimal risk and consequences class* (n=298, 40.4%) contained individuals who had taken less risk on six of the seven items compared to other classes. This class had the lowest rates of drinking at baseline, with the exception of percent days heavy

drinking in which it was the fourth lowest (see tables 5-8). The quality of classification for this class was 0.87.

Table 3. Numbers of classes and model selection criteria

Classes	AIC	ABIC	LMRLRT	BLRT
2	5042.20	5063.61	0.00	0.00
3	4979.08	5011.91	0.00	0.00
4	4963.14	5007.38	0.02	0.00
5	**4950.12**	**5005.78**	**0.02**	**0.00**
6	4954.35	5021.43	0.34	1.00

Figure 1. Conditional item probabilities of the five class solution



Model Covariates

Covariates were added to the model (see Table 4) and were estimated with a logistic regression function, with the *minimal risk and consequences class* used as the reference group. The covariates of having received previous emergency or hospital care for an injury (B=1.27, $p<.001$), attributing the current injury to alcohol use (B=1.31, $p<.001$), and being White (i.e.: Hispanic, B= -1.04, $p<.001$; Black, B= -1.55, $p<.001$) and male (B=1.27, $p<.001$) all significantly influenced inclusion in *the multiple risks and consequences class*. Causal attribution (B=0.62, $p=.01$) and being male (B=0.88, $p=.01$) significantly influenced membership in the *drunk driving foolish risk class*. None of the covariates were significantly associated with membership in the *fighting and foolish risk and class*. For the *accidents and injury class*, only causal attribution (B=1.86, $p<.001$) significantly influenced class membership.

Table 4. Covariates predicting class membership (minimal risks and consequences class comparison group)

Class	Effect	Estimate*	S.E.	*p*
Multiple risks and consequences	Previous ED/hospital treatment for injury	1.27	0.28	0.00
	Causal attribution	1.31	0.29	0.00
	Male	1.27	0.41	0.00
	Hispanic	-1.04	0.31	0.00
	Black	-1.55	0.41	0.00
Drunk driving foolish risk	Previous ED/hospital treatment for injury	0.41	0.23	0.08
	Causal attribution	0.62	0.25	0.01
	Male	0.88	0.32	0.01
	Hispanic	-0.36	0.27	0.17
	Black	-0.60	0.32	0.06
Fighting and foolish risks	Previous ED/hospital treatment for injury	0.96	0.51	0.06
	Causal attribution	0.43	0.45	0.34
	Male	0.69	0.64	0.28
	Hispanic	-0.52	0.56	0.35
	Black	-0.12	0.55	0.82
Accidents and injury	Previous ED/hospital treatment for injury	0.65	0.47	0.17
	Causal attribution	1.86	0.50	0.00
	Male	0.20	0.55	0.72
	Hispanic	-0.35	0.52	0.50
	Black	-0.08	0.59	0.90

***** This estimate is an unstandardized regression coefficient. A significant estimate indicates the covariate is associated with membership in the class.

Distal Outcomes

Percent days abstinent

PDA was added to the model to evaluate drinking as a distal outcome (see Table 5). The largest increase in PDA for early follow up (baseline to six-months) was for the *accidents and injury class*, which experienced a 20 percent increase in days abstinent. This increase was significant with a d of 0.53. The largest overall (baseline to 12-months) increase in abstinence was for the individuals in the *multiple risks and*

consequences class who experienced a 19 percent increase in days abstinent. This increase was significant with a d of 0.47.

Table 5. Changes in percent days abstinent*

	Mean			Changes in Mean			d of change		
Class	Base N=737	6 months N=511	12 months N=420	Base-6mo MARIA n=505	6-12mo MARIA n=414	Base–12mo MARIA n=419	Base to 6 months	6 to 12-months	Base to 12 months
Multiple risks and consequences	52%	71%	71%	**18%**	0%	**19%**	0.46	0.01	0.47
Drunk driving foolish risk	67%	76%	75%	**9**%	-1%	**08**%	0.22	-0.02	0.20
Fighting and foolish risks	66%	80%	77%	4%	-3%	11%	0.53	-0.05	0.35
Accidents and injury	62%	82%	80%	**20**%	**-2**%	18%	0.53	-0.05	0.44
Minimal risk and consequences	74%	81%	77%	**7**%	**-4**%	3%	0.10	-0.13	0.04

*Bolded values represent $p \leq .05$

Percent days heavy drinking

PDHD was added to the model as a distal outcome (see Table 6). The largest significant reduction in PDHD for early follow up was for *the minimal risk and consequences class*, which experienced a decrease of 18 percent PDHD with a d of 0.31. The largest significant overall reduction in PDHD was for the *minimal risk and consequences class*, which experienced a 22 percent decrease with a d of 0.37.

Table 6. Changes in percent days heavy drinking*

	Mean			Changes in Mean			d of change		
Class	Base N=737	6 months N=511	12 months N=420	Base-6mo MARIA n=505	6-12mo MARIA n=414	Base–12mo MARIA n=419	Base to 6 months	6 to 12-months	Base to 12 months
Multiple risks and consequences	70%	62%	60%	-8%	-02%	-10%	0.16	0.03	0.17
Drunk driving foolish risk	64%	52%	49%	-12%	-3%	-15%	0.22	0.04	0.23
Fighting and foolish risks	56%	64%	41%	8%	-23%	-15%	-0.12	0.29	0.23
Accidents and injury	66%	46%	58%	-20%	12%	-9%	0.32	-0.14	0.13
Minimal risk and consequences	58%	40%	36%	**-18%**	-4%	**-22%**	0.31	0.05	0.37

*Bolded values represent $p \leq .05$)

Volume per week

Volume of alcohol consumed each week was also estimated (see Table7). The *multiple risks and consequences class* had the largest significant early follow up and overall reductions, with 14.20 and 14.10 per week drink reductions and ds of 0.43 at each time point. Furthermore, although the *accidents and injury class's* drinking reductions were not significant, effect sizes for early follow up and overall assessments were each 0.50.

Table 7. Changes in average volume consumed per week*

	Mean			Changes in Mean			d of change		
Class	Base N=737	6 months N=511	12 months N=420	Base-6mo MARIA n=505	6-12mo MARIA n=414	Base–12mo MARIA n=419	Base to 6 months	6 to 12-months	Base to 12 months
Multiple risks and consequences	28.10	13.90	14.00	**-14.20**	0.10	**-14.10**	0.43	0.00	0.43
Drunk driving foolish risk	15.30	10.10	10.90	**-5.20**	0.80	**-4.40**	0.22	-0.06	0.38
Fighting and foolish risks	13.40	10.80	10.60	-2.60	-0.20	-2.80	0.09	0.00	0.09
Accidents and injury	20.00	7.10	7.40	-12.90	0.30	-12.60	0.50	-0.01	0.50
Minimal risk and consequences	9.70	6.50	7.50	-3.20	**1.00**	-2.20	0.18	-0.05	0.11

*Bolded values represent $p \leq .05$

Maximum amount consumed

Maximum amount consumed on one occasion was also added to the model (see Table 8). The *accidents and injury class* experienced the largest significant improvements in the maximum amount consumed at the early follow up and the overall assessment periods with reductions of 8.20 and 6.40 drinks and ds of 0.91 and 0.62, for the respective assessment points. The *multiple risks and consequences class* also experienced reductions of 9.60 and 9.0 drinks at the early follow up and overall assessment periods. These reductions were significant with effect sizes of 0.72 at six- and 0.59 at 12-months.

Table 8. Changes in maximum drinks consumed on one occasion*

	Mean			Changes in Mean			d of change		
Class	Base N=737	6 months N=511	12 months N=420	Base-6mo MARIA n=505	6-12mo MARIA n=414	Base–12mo MARIA n=419	Base to 6 months	6 to 12-months	Base to 12 months
Multiple risks and consequences	19.90	10.30	10.90	**-9.60**	0.60	**-9.00**	0.72	-0.04	0.59
Drunk driving foolish risk	14.20	8.10	7.88	**-6.10**	-0.22	**-6.32**	0.10	0.02	0.10
Fighting and foolish risks	15.10	8.90	9.00	**-6.20**	0.10	-6.10	0.67	-0.01	0.57
Accidents and injury	14.00	5.80	7.60	**-8.20**	1.80	**-6.40**	0.91	-0.18	0.62
Minimal risk and consequences	10.70	5.60	6.10	**-5.10**	**0.50**	**-4.60**	0.23	-0.06	0.21

*Bolded values represent $p \leq .05$

DISCUSSION

Multiple Risks and Consequences Class

Findings summary

The *multiple risks and consequences* class members reported some of the highest injury-related drinking consequences and some of the highest baseline alcohol levels. This class also reported the largest effect sizes for significant positive change in PDA and volume per week consumed over the period of the study. However, it was not the only class demonstrating large improvements in drinking outcomes.

Implications

It could be the case that *multiple risks and consequences class* are the patients documented in the trauma research literature as those who are prone to injury recidivism (Brooke, et al., 2006; Morrissey, et al., 1991; Sims, et al., 1989; Smith, et al., 1992).

Despite this, members of this class seem to be most likely to make improvements in drinking. If this proves to be the case, the clinical implications could be important as this class of individuals would be relatively easy to identify given that they had more prior injury-related consequences of alcohol misuse than other patients, were most likely White males, had a history of injury care in an emergency or hospital setting, and believed their current injury was related to their alcohol use.

Drunk Driving Foolish Risk Class

Findings summary

The *drunk driving and foolish risk class* all reported driving after having three or more drinks and reported the second highest level of drunk driving arrests. Males were more likely to be members of this class. The *drunk driving and foolish risk class* reported significant reductions for each alcohol outcome measure, except for the PDHD variable. However, the magnitudes of the significant changes (with a range of 0.10 to 0.38) were smaller in size compared to those made by other classes. In particular, they differed most from the *multiple risks and consequences* and *accidents and injury classes*.

Implications

The findings that men are most likely members of this class coincides with the broader literature that indicates that men are more likely that women to engage in drunk driving (National Highway Traffic Safety Administration, 2009b, 2010). The fact that drinking and driving has a high potential for injury and death of self and others combined with this class's relatively low reduction in drinking suggests these patients may require

more intensive alcohol misuse services or perhaps a booster session following the brief intervention, such as recommended by Longabaugh et al. (2001).

Fighting and Foolish Risk Class

Findings summary

Members of the *fighting and foolish risk class* stand out because their alcohol consequences were largely limited to fighting, and they had the second highest level of injuring others while drinking. Given this group's engagement in fighting, it is not surprising they would be more likely to injure others. This group experienced some of the smallest drinking changes among those who received interventions. This was the only class for which causal attribution was not significantly associated with membership. That is, unlike all other groups, this class of individuals did not connect their alcohol use and injury.

Implications

Previous studies have identified causal attribution as a predictor of change among SBI services recipients (Barnett, et al., 2010; Walton, et al., 2008). The decreased likelihood of change may be a result from this class of individuals failing to attribute their alcohol use to the present injury. Brief interventions including components to specifically elicit and enhance causal attribution could improve change among this class of participants. This group might also benefit from brief intervention with booster or referrals to anger management training.

Accidents and Injury Class

Findings summary

The *accidents and injury class* was most likely to suffer injuries themselves , and this class also demonstrated some of the largest effect sizes in reduction of drinking across time compared to the other classes, such as increases in PDA at early follow up and reductions in maximum amount consumed at early and overall follow up.

Implications

The magnitudes of changes among this class were somewhat unanticipated since those with more severe drinking patterns might be assumed to be more likely to change. For example, greater levels of change could have been expected from the multiple risks and consequences group because they had the most room to change compared to other classes; however, that was not the case. Explanations for this high level of change among the *accidents and injury class* may be the influence of the history of injury care and causal attribution covariates.

Membership in the *accident and injury class* was related to a history of experiencing alcohol-related accidents and injuries but not to a history of care for injuries, suggesting the previous injuries among the members of this class were less severe (did not require hospital care). Reduced drinking in this group may be attributed to hospital admission for one of the first times in their lives for a more severe injury than they had previously experienced for an injury caused by alcohol use—possibly equating to a teachable moment (Blondell, et al., 2002; Vaca & Winn, 2007). Regardless of the

reason for change, individuals in the *accidents and injury class* experienced significant and consistent reductions in alcohol use.

Minimal Risk and Consequences Class

Findings Summary

The *minimal risk and consequences class* possessed the largest number of members and had some of the lowest levels of consequences experienced. Though this group did not report a substantial change in drinking for most outcome variables, it was the only group that experienced a significant mean change (and the largest effects) for reductions in PDHD.

Implications

The low levels of change in this group could be attributed to a possible floor effect. That is to say, these class members started with low risk and low alcohol use, so they had less room to change. However, a floor effect does not appear to be the explanation since heavy drinking was markedly reduced at follow up. Given the association between heavy drinking and injury, this seems to be a clinically relevant outcome, even though other drinking outcomes for this group did not improve. These individuals lacked histories of injury-related consequences, and their PDHD at baseline was the second lowest of all classes. Perhaps members of this class are those identified in the literature as individuals who drink infrequently at high levels and experience high injury rates (Cherpitel, et al., 2010; Gmel, et al., 2006). Despite substantial improvement in PDHD, this group experienced some of the lowest levels of change on other outcome

variables compared to the other groups. Future research is also needed to identify what could enhance change among members in this class. Barring identification of such factors, less intensive and more cost effective strategies (i.e., brief advice) might produce the same changes for this group.

Limitations and Future Research

This study is among the first in the SBI literature to classify participants into latent subgroups in order to assess variability in outcomes. Thus, service delivery recommendations would be premature. Additional research must occur to retest these classifications. In addition, research evaluating the effectiveness of different brief intervention strategies for members of these groups is needed. In connection with the need for replication, one important class feature that warrants future investigations is the size of the classes that emerged in this project. Two classes, the *fighting and foolish risk* and *accidents and injury classes*, each contain less than five percent of the intervention population. Replication studies would confirm the validity and clinical relevance of these classes, which may be larger or redundant with other classes in subsequent samples. Associated with replication studies are translational applications of the findings. The current study was intended to explore the existence of classes among intervention recipients and changes drinking across time. Future research should also examine how these classification findings can be utilized and applied in practice.

A final limitation of the current study is that the behavioral profiles of the classes have only been established in a cross-sectional model. However, because alcohol-related injury involves much more than drinking at high levels, examining profiles across time

would also be helpful in understanding the differential levels of change among intervention recipients and the dynamics of behavioral change. Specifically, longitudinal latent class transition analyses (Collins & Lanza, 2010) would help determine whether or not individuals with higher risk profiles transition into lower risk classes across time, and if transitions occur, at what time point these transitions occur. Moreover, longitudinal analyses could identify if some classes of individuals fail to transition from higher to lower risk classes, or if some individuals increase alcohol use and risk behaviors following brief intervention. Such findings could help providers to more effectively tailor interventions to patients' specialized needs targeting alcohol use and risk behaviors.

CONCLUSION

This study lays the groundwork for understanding changes in drinking behavior among those who are injured and receive SBI. Specifically, this study suggests that the *multiple risks and consequences* and *accidents and injury classes* of individuals experience some of the greatest reductions in drinking following injury, SBI, and discharge. This study has also shown that other classes of intervention recipients reduced their alcohol use but at lower magnitudes. This study also suggests that for certain types of drinking behaviors, namely heavy drinking, the *minimal risk and consequences class* experienced the largest changes compared to other classes.

A better understanding of which patients are likely to respond to SBI could be useful for trauma centers working to help providers target SBI resources. Given that trauma centers often struggle with profitability (Bazzoli, et al., 2005; Selzer, et al., 2001; Shen, et al., 2009) and that SBI reimbursement has been slow to take hold (Behavioral

Healthcare, 2008; Fornili & Alemi, 2007), administrators and clinicians may conserve resources by knowing which patients benefit from SBI. Such knowledge could be used to prioritize brief intervention services, maximize provider use of resources, and improve long-term patient outcomes.

CHAPTER III: Changes in Classes of Injury-Related Risks and Consequences of Alcohol Misuse: A Latent Transition Analysis

INTRODUCTION

Alcohol and Injury

Alcohol-related services in the United States cost more than $185 billion each year (Harwood, 2000). These costs include criminal justice repercussions, lost earnings, and individual health consequences, including injury and accidents (Miller & Hendrie, 2009). Risky drinking is the primary risk factor for injury in the nation (CDC, 2010) and is a major predictor of emergency (Cherpitel & Ye, 2008) and trauma care (MacLeod & Hungerford, 2010). Alcohol-related injuries occur among individuals who regularly drink at high levels (such as those with alcohol use disorders) and occur to a greater degree to those who consume alcohol in binge patterns (Cherpitel, et al., 2010; Gmel, et al., 2006).

In addition to risky drinking and injury, drinking and driving is major contributor to non-fatal injury and is a significant predictor of injury cases admitted to trauma centers (National Trauma Data Bank, 2011; Stoduto, et al., 1993). Nearly one-third of motor vehicle crashes involving alcohol result in injury (National Highway Traffic Safety Administration, 2008b), and driving drunk more than doubles risk for injury (Field & O'Keefe, 2004). Alcohol use and violence are also primary predictors of injury. Violent offenses are often perpetrated by intoxicated individuals or are perpetrated on individuals who have been drinking (Bureau of Justice Statistics, 2010; Collins & Messerschmidt, 1993). Binge drinking, in particular, is common among individuals who perpetrate violent offenses that result in injury (Brewer & Swahn, 2005). Alcohol-related violence

and injury are also leading causes of subsequent treatment in emergency (Cherpitel, 1993) and trauma settings (Field, et al., 2001; Field & O'Keefe, 2004). In a cross-national study of six countries, researchers reported that individuals with a blood alcohol content greater than 0.08 were three times more likely to sustain an intentional (violent) injury than an accidental injury (Macdonald, et al., 2005).

Because of these injury-related risks and consequences of alcohol misuse, it is important to provide help to individuals who are involved in these behaviors. It is unfortunate that most people with alcohol use disorders do not receive help (SAMHSA, 2009). According to the Substance Abuse and Mental Health Services Administration (SAMHSA), roughly 90 percent of individuals in the United States who needed treatment in 2008 for alcohol problems did not receive care (SAMHSA, 2009). It is fortunate, though, screening and brief interventions (SBI) have been developed and tested in an effort to reduce alcohol-related injury or prevent their reoccurrence. SBI for alcohol misuse for injured individuals has been shown to reduce drinking (Antti-Poika, et al., 1988; Bazargan-Hejazi, et al., 2005; Gentilello, et al., 1999; Haque, et al., 2003; Neumann, et al., 2006), injury recidivism (Gentilello, et al., 1999; Longabaugh, et al., 2001), drinking and driving (Monti, et al., 1999), and drunk driving arrests (Schermer, et al., 2006). SBI for injured patients has also been demonstrated to increase levels of treatment seeking for alcohol problems (Neumann, et al., 2006; Runge, et al., 2002). As a result of this empirical support, the American College of Surgeons requires SBI as a standard for Level-1 trauma center accreditation (American College of Surgeons, 2006).

Research indicates, however, that SBI is not effective for all injured patients. Some studies have shown no significant treatment effects in alcohol use reduction (Daeppen, et al., 2007; Dauer, et al., 2006; Dauer, et al., 2003; Dent, et al., 2008; Soderstrom, et al., 2007), alcohol-related adverse driving events (Crawford, et al., 2004; D'Onofrio, et al., 2008; Kunz, et al., 2004; Sommers, et al., 2006), or future injury (Roudsari, et al., 2009). Meta-analyses and systematic reviews of SBI for injured patients have also reported mixed results for the efficacy of SBI among injured patients (Daeppen, 2008; Havard, et al., 2008; Nilsen, et al., 2008). Moreover, in spite of the national accreditation standard for SBI, 80 percent of states in the nation have not made reimbursement for SBI services possible (Behavioral Healthcare, 2008; Fornili & Alemi, 2007). An unfunded service might be justifiable in health care settings where profit margins are adequate, but trauma centers are often rely heavily on governmental sources to remain solvent (Bazzoli, et al., 2005; Selzer, et al., 2001; Shen, et al., 2009). Therefore, SBI in Level-1 trauma departments is left to operate in a challenging service delivery environment.

Analytical Advancement

In light of the mixed evidence for the effectiveness of SBI among injured patients and given the fact that SBI is a required but largely unfunded service for Level-1 trauma centers, it may be helpful to extend the field's current understanding regarding which intervention recipients experience the greatest change following discharge. Some secondary analyses have demonstrated promise for identifying subgroup response to SBI (Barnett, et al., 2010; Field & Caetano, 2010; Field, et al., 2010; Lin, et al., 2010; Mello,

et al., 2005; Walton, et al., 2008); though, these analyses often do not capture the multifaceted nature of alcohol-related injury and associated behaviors. It is evident from the literature that risky alcohol use, drinking and driving, and alcohol-related violence have some interrelationship in predicting the need for injury care. What is not clear is how these factors come together and impact one another for traumatically injury patients who receive SBI.

A potentially more complete approach for understanding changes among those receiving SBI is latent variable statistical modeling. Latent model approaches have a greater ability to establish a theoretical understanding of complex behavioral health outcomes (Collins & Lanza, 2010; Kline, 2010; Lee, 2010; Muthén & Asparouhov, 2006). One method of latent variable modeling that could be especially helpful in the analysis and interpretation of findings from SBI studies is mixture modeling. Mixtures are used to draw out subgroups or "classes" of individuals that exist within the data based on multiple indicators (Collins & Lanza, 2010; McCutcheon, 1987) and then capture changes that transpire among those groups across time (Collins & Lanza, 2010; Nylund, 2007). Such an approach can provide a clearer picture of the combination of risks and consequences individuals experience and then depict what changes in those behaviors are manifest across time. The purpose of this secondary analysis was to model the longitudinal injury-related consequence and risk behavior profile changes patients experienced following the receipt of a brief alcohol intervention and discharge from a trauma center.

MATERIALS AND METHODS

Data Source

Data from a SBI randomized clinical trial conducted in a Level-1 trauma department was used in this project (P.I.: Caetano, R., NIAAA, R01 013824). The consort chart (i.e., the numbers of patients of patients screened, recruited, and that completed follow up), specific methods of participant recruitment, and detailed descriptions of experimental and control conditions for this trial have been reported elsewhere (Field & Caetano, 2010; Field, et al., 2010; Field, Caetano, & Pezzia, 2009; Roudsari, et al., 2009). All study participants were adults (≥18 years) who suffered a traumatic injury, were admitted to a Level-1 trauma center, and screened positive for alcohol misuse. Specifically, patients recruited for participation in the study had a clinical indication of intoxication upon admission to the trauma center (but not intoxicated at the time of recruitment), reported drinking six hours before the injury event, reported drinking at NIAAA risk levels (NIAAA, 2007), or responded positively to one or more items of the CAGE (Ewing, 1984; Kitchens, 1994). Informed consent was obtained from participants according to procedures approved by the university and medical center Institutional Review Boards. Following consent, participants were assigned to receive a brief motivational intervention or treatment as usual. This dataset contains 1,493 cases and includes self-reported information from baseline, six-, and 12-month assessments regarding alcohol use and alcohol risk information. The sample is comprised of 1,231 men and 262 women, of whom 668 are White, 288 are Black, and 537 are Hispanic.

Follow up rates in this study have been reported elsewhere and are comparable to other brief intervention clinical trials (Field, et al., 2010).

The main outcomes from the original trial found time effects for alcohol use (Field, et al., 2010) among both groups and significant interaction effects for reductions in drinking among Hispanics (Field, et al., 2010) and those dependent on alcohol (Field & Caetano, 2010). Data from the experimental group only (n=737) was used in the present study because the intent of the current project was to conduct a descriptive longitudinal analysis of transitions among individual behavioral profiles based on injury-related consequence and risks of alcohol misuse for those participants who received SBI. In other words—the purpose of this project was to describe if individual intervention recipients' profiles improved, stayed the same, or worsened following discharge from the trauma center.

Model and Analytic Approach

The specific mixture modeling approach selected for this project was latent transition analysis (LTA; Collins & Lanza, 2010; Muthén & Muthén, 2009; Nylund, 2007). LTA models build on cross-sectional latent class analyses (LCA). LCA is a model-based approach for identifying subgroup homogeneity based on similar responses to measured variables from within a heterogeneous population (Collins & Lanza, 2010; Connell, Cook, Aklin, Vanderploeg, & Brex, 2011; Lanza, et al., 2007; McCutcheon, 1987). LTA was selected as the analytical approach for this project in order to depict longitudinal transition patterns among latent subgroups of intervention recipients (Collins & Lanza, 2010). The LTA carried out in this project followed modeling building

procedures outlined in the literature (Collins & Lanza, 2010; Muthén & Muthén, 2009; Nylund, 2007; Nylund, et al., 2007) by first establishing cross-sectional LCAs of injury-related risks and consequences of alcohol misuse at two different time points and then incorporating those into a single LTA model.

The first LCA model depicts subclasses of participant injury-related risks and consequences of alcohol misuse assessed at baseline of the SBI study. This baseline model includes participants' risks and consequences in the year prior to admission to the trauma center. The second LCA model is based on the 12-month follow up assessment and includes the same risks and consequences of alcohol misuse captured in the first model but for the year after discharge. These cross-sectional latent class models were established using the Akaike Information Criterion (AIC), Adjusted Bayesian Information Criterion (ABIC), and Bootstrapped Likelihood Ratio Test (BLRT; Collins & Lanza, 2010; Muthén & Muthén, 2009; Nylund, et al., 2007). Following the establishment of the cross-sectional LCAs, these models were combined into a single LTA longitudinal model to examine if transitions between behavioral profiles occurred. All analyses were conducted using Mplus 6 (Muthén & Muthén, 2010a). In addition to the latent models developed and tested, descriptive analyses of participant demographic characteristics were calculated using IBM SPSS 19 (IBM, 2011) and are reported.

Variables

Table 9 contains the variables utilized in the cross-sectional measurement models. Items from the Short Inventory of Problems (SIP) +6 were selected for analysis in this study (CASAA, 1994). The additional six items added to the standard SIP come from the

Drinker Inventory of Consequences (DrInC-2L; CASAA, 1995). The seven items selected from the SIP+6 are the injury-related risks consequences of alcohol misuse that are among those identified factors that lead to emergency and trauma care (Longabaugh, et al., 2001; Soderstrom, et al., 2007). The time periods measured the 12-month period prior to patients' current trauma center admission and 12 months after discharge.

Table 9. Observed indicators from 12 months before and after SBI

Observed Indicator
I have driven a motor vehicle after having three or more drinks (SIP+6)
I have taken foolish risks when I have been drinking (SIP)
I have gotten into a physical fight while drinking (SIP+6)
I have been arrested for driving under the influence of alcohol (SIP+6)
I have had an accident while drinking or intoxicated (SIP)
While drinking or intoxicated, I have been physically hurt, injured or burned (SIP+6)
While drinking or intoxicated, I have injured someone else (SIP+6)

RESULTS

Study Sample and Characteristics

The total number of participants who were assigned to the intervention group at baseline was 737. However, due to attrition at follow up in the parent study, 73 participants were missing all data in the combined six- and 12-month follow up assessments. Therefore, 664 participants were included in the current LTA. These participants were mostly males (n=571, 86%), and their average age was 33 years (SD=11.5). Whites were the largest racial/ethnic group (n=303, 45.6%) followed by Hispanic (n=228, 34.3%) and Black (n=133, 20%, 20.1%) participants. Approximately one-third of participants were married (n=188, 28.3%), had a high school diploma/GED

(n=241, 36.3%) or some high school education (n=245, 36.9%), and were not employed (n=211, 31.8%). Most injuries participants sustained were unintentional (n=522, 78.6%).

Proportional and mean difference tests (results not shown) were conducted to examine whether demographic characteristics for participants assigned to receive the intervention at baseline (N=737) and those participants who were included in the present LTA (N=664) differed. Similar to the significant follow up differences reported in the main outcomes paper of the parent study by Field et al. (2010), Hispanic (standardized residual=1.8) participants included in the LTA were more likely (χ^2=6.9, df=2, p=0.04) to have not completed the follow ups compared to White (standardized residual= -1.6) and Black (standardized residual=0.1) participants. No other significant differences emerged between participants who received the intervention at baseline and those included in the current study.

Classes and Conditional Item Probabilities

Four class solutions were supported for the year before the current injury and for the year after the current injury (see Table10). Models parameters were allowed to estimate freely, without imposing full or partial model constraints (Collins & Lanza, 2010; Nylund, 2007). Based on the assessment of differences in the classes (Nylund, 2007) at time-one compared to time-two, the free estimation of parameter values was judged for this LTA to have the ability to represent the most accurate changes among study participants. Figures 2 and 3 plot the conditional item probabilities for each time point for the four class solutions. The four classes for time-one were labeled: 1a, 2a, 3a, and 4a. The classes for time-two were labeled: 1b, 2b, 3b, and 4b.

Table 10. Numbers of classes identified from data

	Classes	AIC	ABIC	BLRT
12 months before SBI				
	2	1749.87	1768.11	0.00
	3	1736.90	1764.86	0.00
	4	**1735.18**	1772.86	**0.02**
	5	1742.55	1789.95	0.37
12 months after SBI				
	2	1472.35	1483.82	0.00
	3	1433.99	1451.58	0.00
	4	**1423.86**	**1447.56**	**0.00**
	5	1429.73	1459.56	0.50

Year prior to injury

Class 1a contains 341 individuals (51.3%) and represents the group with the highest probabilities of endorsing each of the seven SIP+6 items. All 1a class members endorsed four of the seven items; the item with the lowest probability of endorsement in class 1a was drunk driving arrests, with a 63 percent probability of endorsement. Class 2a contains 143 (21.5%) individuals. All 143 members had injured themselves while drinking in the year before their current injury admission, and they were the second most likely of any class to have experienced an accident (76.3%) and to have injured others (72.3%). Class 3a contains 25 individuals (4%). Nearly all class members had driven after drinking (95.3%); over three-quarters had been in fights (77.9%), and all had done foolish things. The last class group, class 4a, included 155 (23.3%) individuals. These study participants had the lowest probabilities of endorsements of each of the seven SIP+6 items compared to the other classes, with having an accident (39.6%) being the highest item probability in the class.

Year after injury

Class 1b contains 22 individuals (3.3%). This class of individuals contained the highest probabilities of item endorsement, with all class members endorsing three items; the lowest probability of item endorsement in class 1b was injuring others, at 25 percent. Class 2b contains 23 study participants (3.4%). All members of this class had been in fights while drinking, and this class had the highest probability of injuring others (80.8%) and the second highest probability of injuring self (73%). Class 3b contains 359 individuals (54.1%). This class was primarily characterized by drinking and driving (79.9%) and doing foolish things while drinking (64%). Class 4b contains 260 individuals (39.2%), with most individuals endorsing none of the risk consequences except for drinking and driving, which had a 21.3 percent probability of endorsement.

Figure 2. Conditional item probabilities for four class solutions one year before SBI

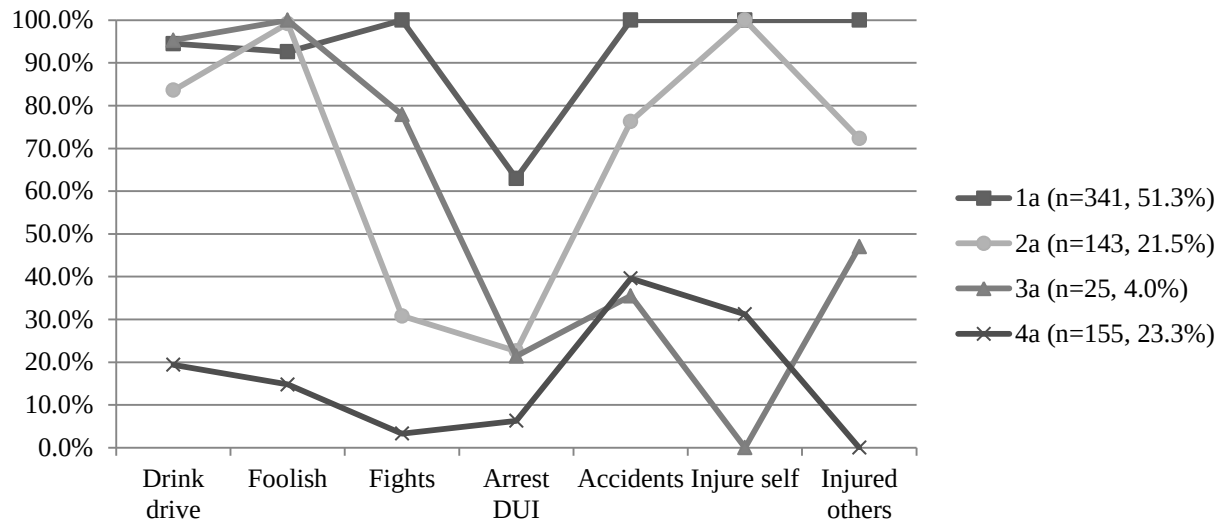
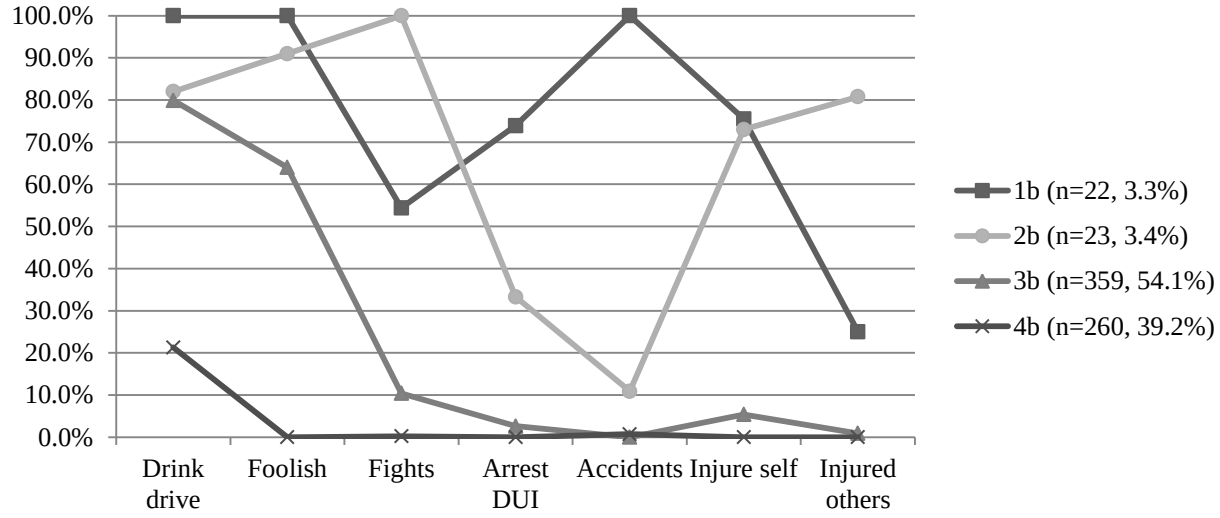


Figure 3. Conditional item probabilities for four class solutions one year after SBI



Transitions

As is shown in Table 11, the largest number of people in a transition group was for those 310 individuals who moved from class 1a (the highest risk class at time-one)

into class 3b (a class with some of the lowest risk at time-two with the exception of drinking and driving and foolish risks while drinking). Another transition for class 1a included members transitioning into classes 1b (4.4% n=15, the highest risk class at time-two) and 2b (4.4% n=15, a class characterized by high risks at time-two with the exception of DUIs and alcohol-related accidents). Nearly all (94.4%; n=135) individuals in class 2a (the class with high risks for accidents and injuring self at time-one) moved to class 4b (a class with the lowest risks compared to others) at time-two. Individuals in class 2a also transitioned into classes 1b (4.2%, n=6, the highest risk class at time-two) and 2b (1.4%, n=2, a class characterized by high risks at time-two with the exception of DUIs and alcohol-related accidents). The only transition that occurred for class 3a was that each of these participants moved into class 3b at time-two. Members of class 4a transitioned into class 4b (80%, n=124; a class characterized by the lowest levels of risks at time-two). Members of class 4a also transitioned into class 2b (3.9%, n=6, a class characterized by high risks at time-two with the exception of DUIs and alcohol-related accidents) and 3b (15.5%, n=24; a class characterized by high levels of drinking and driving and foolish risks while drinking).

Table 11. Percent of classes transitioning (total individuals in transition class)

	Year following injury and intervention classes			
Baseline classes	1b	2b	3b	4b
1a	4.4% (15)	4.4% (15)	90.9% (310)	0.3% (1)
2a	4.2% (6)	1.4% (2)	0% (0)	94.4% (135)
3a	0.0% (0)	0.0% (0)	100% (25)	0.0% (0)
4a	0.6% (1)	3.9% (6)	15.5% (24)	80.0% (124)

DISCUSSION

The results of this latent transition analysis demonstrated that four groups of individuals experienced injury-related consequences and risks of alcohol misuse in the year before and the year following their current injury and intervention. This study also demonstrated many individuals transition from baseline classifications into other groups across time—with most transitions appearing to be positive, while some other transitions demonstrated marginal improvement.

Transitions for Class 1a

In the year following the current injury, nearly all individuals initially classified in 1a class (the class with the highest risk at time-one) transitioned into lower consequence groups in the second year, with the largest number of individuals moving into 3b, a class with almost no reports of four injury-related consequences of alcohol misuse indicators. However, those in class 3b had an 80 percent probability of endorsing driving after drinking. This finding calls attention for providers to heavily target drinking and driving behaviors—given their lethal potential—when providing intervention services to injured patients (National Highway Traffic Safety Administration, 2010). If replicated in future studies, these findings may give cause to accrediting bodies to require drinking and driving counseling and/or information delivery as part of SBI.

In addition to high levels of drinking and driving at time-two, nearly 10 percent of 1a class members transitioned into classes 1b and 2b. Transitions into class 1b are problematic because this class had the highest risk profile in year two. Transitions into class 2b are also problematic given this group's high probabilities for drinking and

driving, taking foolish risks, fighting, and injuring self and others during the follow up year. Future research should study approaches to help this subset of study participants to make more favorable transitions.

Transitions for Class 2a

The transition from class 2a into 4b was one of the most favorable study results, as class 2a was one of the highest risk baseline groups and 4b was the lowest risk group at time-two. Notwithstanding this positive transition, class 4b had a 20 percent probability of endorsing drinking and driving at time-two. Once again, this finding calls attention to the need for providers to focus on reducing drunk driving behaviors post-discharge. Furthermore, about five percent of members of class 2a transitioned into classes 1b and 2b. While not a large contingency of those who received SBI, transitions from 2a into classes 1b and 2b are problematic as both of these classes (as detailed above) reported high levels of injury-related risks consequences of alcohol misuse.

Transitions for Class 3a

At time-one, about five percent of study participants were categorized in class 3a; all of these participants transitioned into class 3b at time-two. Transitioning from one lower risk group into another lower risk group may be in itself a positive finding, especially since in class 3b nearly all injury-related risks and consequences of alcohol misuse were eliminated. The exception to this positive finding is the lack of a major reduction in drinking and driving behaviors—again calling attention to the need to focus on drinking and driving at multiple levels of SBI service delivery.

Transitions for Class 4a

The majority of those individuals in class 4a at time-one transitioned into in class 4b. Transitioning from class 4a to 4b may be considered a positive outcome, especially given that drinking-related accidents and injuring self as the predominant consequences experienced at time-one were nearly non-existent at time-two. However, those in class 4b had a 20 percent probability of driving after drinking, again pointing to the need emphasize drinking and driving with trauma patients who misuse alcohol.

Additionally, nearly 20 percent of those in 4a transitioned into classes 2b and 3b. These transitions are especially problematic due to the fact that while class 4a had modest levels of alcohol-related accidents and injuries at time-one, class 2b reported a number of high risk behaviors at time-two, and 3b had a roughly 80 percent probability of drinking and driving, 64 percent probability of foolish risks, and a 10.4 percent probability of fighting. Indeed, movement from 4a into 2b and 3b represent transitions from a profile at baseline that primarily included hurting oneself into other profiles that included externally dangerous activities, such as drinking and driving.

Limitations

Three primary limitations should be taken into account when considering this study's findings. First, the parent trial upon which this study is based was not designed to answer the specific questions addressed in this secondary analysis regarding transitions among subgroups. With more precise measures of injury-related risks and consequences of alcohol misuse and a research design specific to transition patterns, classes of trauma patients may be more accurately assessed.

A second potential limitation is that since this study is one of the first of its kind in brief alcohol intervention analysis, classes and transition probabilities were allowed to estimate freely. Though this approach provides the clearest statistical picture of changes among injury-related consequences and risks of alcohol misuse classes, class transitions and conditional item probabilities are more difficult to interpret as they are not uniform across time. Future analyses may benefit from using information from the present or similar studies in examining models for which some level of invariance is imposed to increase uniformity and facilitate interpretation of results.

A third potential limitation is small class sizes. At time-one, class 3a contained 25 individuals (4%), and at time-two, class 1b had 22 individuals (3.3%), and class 2b had 23 individuals (3.4%). While these smaller class sizes at both time points could indicate that the smaller groupings may simply represent trivial classes unique only to this dataset, qualitative distinctions between the classes provide some temporal evidence of the uniqueness of the classes. In particular, the probability plots demonstrate that no one class is at the same level of severity as another. Rather, the classes are sufficiently different that one could not easily be encapsulated into another without losing important distinctions in class characteristics. As such, limiting models to a fewer class solution would hinder the current more complete characterization of the data. Replications of the four class solution at each time point would provide additional insight into whether these classes are indeed distinct groups of participants or are artifacts of the analyses. Nevertheless, it is positive that many individuals transitioned into less risky groups following discharge from the trauma center.

CONCLUSION

At-risk drinking, driving under the influence of alcohol, and alcohol-related violence are among the primary risk factors that result in injuries that require medical care in the nation's emergency and trauma centers. Since individuals who misuse alcohol do not frequently receive specialty alcohol treatment, it is fortunate that emergency and trauma settings have been recognized as critical locations to identify, intervene, and provide interventions services. It is not clear from the extant research literature which individuals make positive changes following the receipt of brief interventions. The current study sought to identify which groups of individuals experience the most behavioral change following a brief intervention. The LTA conducted in this study demonstrated that four subclasses of participants could be identified in the year before and the year after the intervention based on injury-related risks and consequences of alcohol misuse.

Most individuals transitioned from classes with higher endorsements of injury-related risk and consequences of alcohol misuse into classes with lower endorsements. Nevertheless, drinking and driving remains a persistent issue in the year following the SBI service delivery. Replications of these findings could provide the necessary support for accreditation or practice level enhancements to deliver specific drinking and driving information to patients. Additionally, some transition classes experienced little or no positive change from time-one to time-two. Future research should focus on how to better service those whose behavioral profiles do not improve following SBI services and

discharge. Such evidence can be used to likewise improve accreditation standards and service delivery for injured patients who misuse alcohol.

CHAPTER IV: Latent Classes among Recipients of a Brief Alcohol Intervention: A Replication Analysis

INTRODUCTION

Screening and brief intervention (SBI) is a method to address alcohol misuse and the alcohol-related behaviors that often precede injury (D'Onofrio & Degutis, 2002; Havard, et al., 2008; Nilsen, et al., 2008). SBI includes screening patients for alcohol misuse followed by a 15-30 minute conversation wherein providers help those who screen positive for risky drinking to explore their interest and motivation to reduce alcohol use and other risk behaviors (Dunn & Ostafin, 2005; Field, Hungerford, & Dunn, 2005). As part of the accreditation standards for Level-1 trauma centers (American College of Surgeons, 2006), the American College of Surgeons requires that all patients be screened for alcohol misuse, and if positive, receive brief intervention. In spite of this requirement for service, SBI is not reimbursed in most states (Fornili & Alemi, 2007; Fussell, Rieckmann, & Quick, 2011). The cost of SBI is about $55 per patient (Gentilello, Ebel, et al., 2005), and considering that up to 50 percent or more of trauma patients have been observed to misuse alcohol (Gentilello, et al., 1999; MacLeod & Hungerford, 2010), the costs for SBI have the potential to mount as trauma centers typically rely heavily on government subsidies to remain solvent (Bazzoli, et al., 2005; Selzer, et al., 2001; Shen, et al., 2009). These challenges for SBI in trauma centers are compounded by the fact that SBI trials and systematic and meta-analytic reviews indicate that evidence for providing brief intervention to injured patients is mixed (Crawford, et al., 2004; D'Onofrio, et al., 2008; Daeppen, et al., 2007; Daeppen, 2008; Dauer, et al., 2006; Dauer, et al., 2003;

Dent, et al., 2008; Field, Baird, et al., 2010; Kunz, et al., 2004; Soderstrom, et al., 2007; Sommers, et al., 2006). Taken together, lack of provider reimbursement and the unclear empirical support produce a challenging environment for delivering brief alcohol interventions to injured patients in Level-1 trauma centers.

One approach to address these shortcomings would be to target brief intervention services to those who are most likely to change their behaviors. It is not clear from the literature, however, which patients change and which patients do not change following injury, admission, brief intervention, and discharge from the trauma center (Field, Baird, et al., 2010). Researchers have identified risky alcohol use (CDC, 2010), drinking and driving (McLellan, et al., 1990; Stoduto, et al., 1993), and alcohol-related violence (Borges, et al., 2004; Collins & Messerschmidt, 1993; Macdonald, et al., 2005; Swahn, Simon, Hammig, & Guerrero, 2004) as major predictors of injury and subsequent care in emergency departments and trauma centers. Similarly, ethnicity (Field, et al., 2010), gender (Gentilello, et al., 1999), adverse driving events (Mello, et al., 2005), high levels of drinking and alcohol-related risks (Lin, et al., 2010), violence perpetration (Watt, et al., 2008), and causal attribution (believing one's drinking is the cause of the injury; Barnett, et al., 2010; Walton, et al., 2008) have been identified as possible factors associated with response to SBI. What has not been captured is how these antecedents of injury and the factors associated with SBI response come together and impact one another to identify which patients make the greatest changes and which patients make the fewest changes following an injury, admission to a trauma center, receipt of SBI, and discharge.

The Replication

The first paper in this dissertation (to be referred to as the MARIA LCA) reported the results of a latent class analysis (LCA) of injured patients based on past injury-related risks and consequences of alcohol misuse. The MARIA LCA was a secondary analysis of data from the Multidisciplinary Approach to Reducing Injury and Alcohol Project (MARIA Project; P.I.: Caetano, R., NIAAA, R01 013824; recruitment completed in 2005). The MARIA Project was a SBI clinical trial conducted in a Texas Level-1 trauma center. The results of the MARIA LCA identified that five subclasses of individuals existed among those who received a brief intervention in a Level-1 trauma center. These five classes were labeled: (1) *multiple risks and consequences*, (2) *drunk driving foolish risk*, 3) *fighting foolish risks*, (4) *accidents and injury*, and (5) *minimal risk and consequences*. Results from the MARIA LCA also showed that the *multiple risks and consequences class* and the *accidents and injury class* reported the largest improvements in drinking behaviors during the year following discharge from the trauma center. Recommendations from the MARIA LCA suggested that, given the fact that some subgroups of patients experienced greater changes than others, brief interventions could be targeted to those patients most likely to change their behaviors.

The MARIA LCA was based on an individual dataset and is the only study of its kind to be conducted to date. Because a central tenant of the scientific method is to conduct research that can be replicated in order to increase the objectivity, accuracy, and generalizability of results (Bowling, 2009; Rubin & Babbie, 2008), a model replicating the MARIA LCA would provide added support for: (1) the existence of subclasses of

injury-related risks and consequences of alcohol misuse among injured patients, (2) the identification of specific changes in drinking behaviors among those classes, and (3) the recommendations for more targeted brief intervention services.

The current paper reports a partial replication of the results of the MARIA LCA utilizing data from Delta Project (P.I.: Dischinger, P., NIAAA, R01 AA09050-04A2; recruitment completed in 2002). Delta Project was a similar yet separate SBI clinical trial conducted in a Maryland Level-1 trauma center.

METHODS

Sample

As mentioned, the MARIA LCA relies on data from a large-scale SBI clinical trial conducted in a Dallas, Texas, Level-1 trauma center. The MARIA project recruited adult (≥18 years) injured patients who had: (1) a clinical indication of intoxication upon admission to the trauma center (but not intoxicated at the time of recruitment), (2) reported drinking six hours before the injury event, (3) reported drinking at NIAAA risk levels in the past year (NIAAA, 2007), or (4) were positive on one or more items of the CAGE. MARIA participants were randomized to receive: a brief motivational intervention or information only (Field, Raul Caetano, et al., 2010). The MARIA dataset contains 1,493 cases with baseline, six-, and 12-month alcohol use and alcohol risk information on 1,231 men and 262 women, of whom 668 are White, 288 are Black, and 537 are Hispanic (see Field et al. [2010] for study details). Follow up rates in the MARIA study have been reported elsewhere and are comparable to other brief intervention clinical trials (Field, et al., 2010).

To determine if the MARIA LCA results would replicate, the current study utilized data from the Delta Project, a SBI clinical trial conducted in a Baltimore, Maryland, Level-1 trauma department. Delta Project recruited adult (≥18 years) injured patients who screened positive on two successive screening assessments. To be positive on the first screening, a patient had to report one or more of the following: (1) drinking 24 hours previous to their current injury, (2) consuming three or more drinks on a typical drinking day, (3) drinking alcohol on four or more days in the week prior to the screen, or (4) currently or regularly using illicit drugs. Meeting any of these criteria, a second screen was administered. To be positive on the second screen, patients had to report any of the following: (1) one positive item of the CAGE, (2) drinking two or more times per week with a weekly total of 15 or more drinks for men and 8 or more for women, (3) drinking two to four occasions each month with a typical consumption level of five or more drinks for men and four or more drinks for women, or (4) drinking six or more drinks on one occasion, weekly, daily, or almost daily. Delta Project participants were randomized to receive: a brief personalized motivational intervention or information-based advice (Soderstrom, et al., 2007). The Delta dataset contains 497 cases, with baseline, six-, and 12-month alcohol use and alcohol risk information on 423 men and 74 women, of whom 311 are White, 175 are Black, and 11 are from other races (see Soderstrom et al. [2007] for study details). Follow up rates in this study have been reported elsewhere and are comparable to other brief intervention clinical trials (Soderstrom, et al., 2007).

Although the MARIA and Delta trials are similar in many aspects, two differences should be noted. The first is both datasets contain many White and Black

participants; however, the MARIA project also includes a number of Hispanic participants as it was designed to test racial/ethnic difference between groups (Field & Caetano, 2010; Field, et al., 2010), whereas testing such differences was not an aim of the Delta Project. Therefore, some model differences were anticipated and some racial/ethnic comparisons are limited. The second is that Delta project included "abusive/ hazardous/ harmful alcohol use" and excluded those with the most severe alcohol problems (i.e., patients meeting one of the following three criteria: (1) those with a need for medical management for alcohol withdrawal and/or pain; or (2) current enrollment in alcohol treatment, except for self-help; or (3) meeting *all* of the following criteria: >3 score on the CAGE in the past 12 months, *and* consuming alcohol four or more times per week, *and* consuming six or more drinks on one occasion each day or almost each day, *and* drinking five or more drinks for men and four or more drinks for women; see Soderstrom et al. (2007). In contrast, MARIA did not limit recruitment based on alcohol use severity. As a result, some model differences based on alcohol use severity were also anticipated. However, in spite of these potential differences, the medical settings, urban locations, study designs, and types of interventions were judged adequately similar to support a model replication.

A summary of the published findings to date from the MARIA and Delta datasets can be seen in Table 12. In the MARIA project, primary findings indicated that Hispanic and alcohol dependent drinkers in the treatment condition responded more favorably to the intervention compared to controls (Field & Caetano, 2010; Field, Raul Caetano, et al., 2010). Primary findings in Delta project showed time effects for improvements in both

groups (Soderstrom, et al., 2007). The MARIA LCA, conducted in this dissertation, and the current Delta replication included only the brief intervention groups because these studies were intended to identify if latent classes existed among those who received SBI, and if so, to provide descriptive analyses of the variability in changes for post-discharge drinking among risk/consequence latent classes. That is to say, the MARIA LCA study and the current Delta replication LCA sought to determine if participants fell into subgroups and which group had the greatest or the least improvement for the drinking after discharge. Therefore, main effects for treatment were not examined in these studies as those effects were beyond the scope of these projects and have been reported previously.

Table 12. Outcomes of analyses of the MARIA and Delta datasets

Study	First Author	Year	Main finding
MARIA	Field	2010	Moderation effect among Hispanics improving alcohol misuse
	Field	2010	Moderation effect among Hispanics with cultural match with interventionist for improving alcohol misuse
	Field	2010	Moderation effect among alcohol dependent participants improving alcohol misuse
	Field	In press	Moderation effect among drug dependent Hispanics improving alcohol misuse
	Field	In press	Alcohol use improvements among Hispanics were not attributable to treatment seeking behaviors before or after SBI delivery
	Roudsari	2009	No reductions in subsequent injury
	Roudsari	2011	Acute intoxication and alcohol dependence are associated with higher use of health care services for trauma patients
Delta	Soderstrom	2007	Significant improvements in alcohol use for both the brief motivational intervention and information based advice study groups
	Ryb	2011	Decreases in drinking were not associated with participant self-reported impulsivity and depression

Variables

The literature identifies injury-related risks and consequences of alcohol misuse as specific factors that drive individuals to seek emergency and trauma care (Field & O'Keefe, 2004; Gentilello, et al., 1999; Macdonald, et al., 2005; McLellan, et al., 1990; Soderstrom, et al., 2007; Stoduto, et al., 1993). The variables selected for analysis in the MARIA LCA and the Delta replication, therefore, were items from the Short Inventory of Problems (SIP) +6 (Soderstrom, et al., 2007) that measure these behaviors and consequences. The additional six items (+6) in this measure come from the Drinker Inventory of Consequences (CASAA, 1995). The SIP+6 asks participants to indicate whether or not they had engaged in the behaviors or experienced consequences from their drinking. These items were: (1) I have driven a motor vehicle after having three or more drinks (SIP+6); (2) I have taken foolish risks when I have been drinking (SIP); (3) I have gotten into a physical fight while drinking (SIP+6); (4) I have been arrested for driving under the influence of alcohol (SIP+6); (5) I have had an accident while drinking or intoxicated (SIP); (6) While drinking or intoxicated, I have been physically hurt, injured or burned (SIP+6), and (7) While drinking or intoxicated, I have injured someone else (SIP+6).

Covariates estimated in the replication are also similar to those included in the MARIA model; they were: (1) previous ED/hospital treatment for injury; (2) causal attribution of the current injury to alcohol misuse; (3) gender, and (4) race. The purpose of adding covariates to the model is to identify factors that predict class membership. It should be noted that in the original MARIA LCA the race covariates entered into the

model were yes/no Hispanic and yes/no Black variables. To allow the two models to more closely approximate one another, the MARIA LCA was rerun in the present project exchanging the original Hispanic and Black covariates with yes/no White. The race covariate then entered into the Delta replication model was also yes/no White.

Distal outcomes estimated were self-report quantity and frequency (Greenfield, 2000; Midanik, 1994) measures of alcohol use at baseline, six-, and 12-month follow ups. Standard drinks were measured as 12 ounces of beer, five ounces of wine, or 1.5 ounces of distilled spirits (Dawson, 2003). Volume of alcohol use per week was calculated by multiplying quantity of drinks per occasion by frequency of drinking each week (Dawson, 2003). Percent days abstinent (PDA) estimations were based on individual participants' frequency of drinking. Percent days heavy drinking (PDHD) were calculated by dividing the frequency of having *five* or more drinks per drinking occasion in MARIA or having *six* or more drinks per drinking occasion in Delta by participants' drinking frequency. One difference between datasets should be noted for the distal outcomes. Although changes in maximum amount consumed were reported in the MARIA LCA, they are not reported in the current replication project because maximum amount of alcohol consumed on one occasion was not asked of Delta participants.

Analyses

The procedures employed for calculating the LCA are described in detail in the MARIA LCA paper of this dissertation. Latent class analysis is a method for identifying similar patterns of item endorsement for a response set among a group of individuals. The similar response patterns identified therefore constitute profiles or classes of study

participants. The individual indicators selected for analysis in the current project were seven SIP+6 indicators. Although LCA models can be forced to have a specific number of classes, the replication LCA in the current paper followed a conventional model fitting process in order to determine the optimum number of classes that best fit the Delta data and in order to match the procedures used in the MARIA LCA. LCA models are developed by testing an increasing number of classes; that is, a two-class solution is tested, then three, and so on, until an optimal number of classes is identified. The optimal number of classes is identified using fit criteria and likelihood ratio tests. In the current analysis, the Akaike Information Criterion (AIC), Adjusted Bayesian Information Criterion (ABIC), and Bootstrapped Likelihood Ratio Test (BLRT; Collins & Lanza, 2010; Muthén & Muthén, 2009; Nylund, et al., 2007) were employed for establishing the number of classes. An example of one class could be if half the items in a response set about drug use problems reported social problems and all others in the set were about personal problems. If all the social problems items were endorsed at a probability of 0.95 while all the personal problems items were endorsed at a probability of 0.05, such a profile could be labeled the "social problems" class.

Covariates and distal outcomes were also estimated. Significant differences between means for the drinking outcomes were analyzed by conducting Paired Sample T-tests using most likely class membership. All analyses were conducted using Mplus 6 (Muthén & Muthén, 2010a) and IBM SPSS 19 (IBM, 2011). Building on the previous example of LCA, the covariate of gender and the outcome of depression level at subsequent time points could hypothetically be added to the model. If being male had a

significant association with the social problems class and if level of depression increased across time for the social problems class, this would indicate that men are more likely to be in the social problems profile associated with drug use and have increased levels of depression over time. Thus, the value of LCA, as opposed to traditional variance testing or regression models, is that it is a person centered (as opposed to factors) model-based classification technique that can also identify individual-level predictors of class membership and longitudinal changes for targeted outcome behaviors.

Lastly, given that a specific statistical test (such as a Chi-square test that would be used in SEM applications) does not exist to assess if the overall models are similar or different from one another (as indicated through consultation with a statistician who is an expert in statistical modeling, Michael Mahometa, Ph.D., personal communication, January 2012 and via communication on the Mplus discussion board: Bengt Muthén, Ph.D., personal communication, February 2012), comparisons of similarities between the estimated LCA models in this paper followed previously published approaches (Grant et al., 2006). These include direct comparisons of models' conditional item probabilities and significance of covariates and alcohol misuse improvements.

RESULTS

A total of 250 participants were analyzed from the Delta Project (737 cases were included the MARIA LCA; see Table 13). Demographic comparisons between baseline variables showed significant differences between race/ethnicity in that Whites were over represented and minorities were under represented in the Delta sample. There were also fewer study participants in the Delta sample than in MARIA who had less than a high

school education/GED equivalent or were married. Lastly, although baseline comparisons between Delta and MARIA for numbers of alcohol dependent participants cannot be calculated, MARIA participants reported significantly higher baseline percent days heavy drinking and percent days abstinent than those in the Delta sample, indicating possible binge use patterns among MARIA participants.

Table 13. Population characteristics

		Delta		MARIA				
Characteristic		#	%	#	%	χ^2	df	*p*
Gender	Male	212	84.8	630	85.5	0.07	1	0.79
	Female	38	15.2	107	14.5			
Race/Ethnicity	White	157	63.1	326	44.2	26.4	1	<0.001
	Racial/ethnic minority	92	36.9	411	55.8			
Education	More than High School	76	30.4	196	26.6	9.1	2	0.01
	High School Diploma/GED	106	42.4	263	35.7			
	Less than High School	68	27.2	278	37.7			
Marital Status	Married/cohabitating	54	21.6	214	29.0	5.2	1	0.02
	Not married/cohabitating	196	78.4	523	71.0			
Age*		33.3	12.4	33.4	11.4	-0.1	985	0.93
Baseline Alcohol Use	Alcohol dependence	---	---	306	47.1	---	---	---
	Percent days abstinent*	0.57	0.3	0.67	0.3	-4.7	985	<0.001
	Percent days heavy drinking*	0.55	0.4	0.62	0.4	-2.6	985	0.01
	Average volume consumed*	17.21	16.4	15.47	22.1	1.14	985	0.25

*Mean, standard deviation, t-value, df, and *p*

As was reported in paper one of this dissertation, a five-class solution emerged from among MARIA study participants who received the intervention. In the current

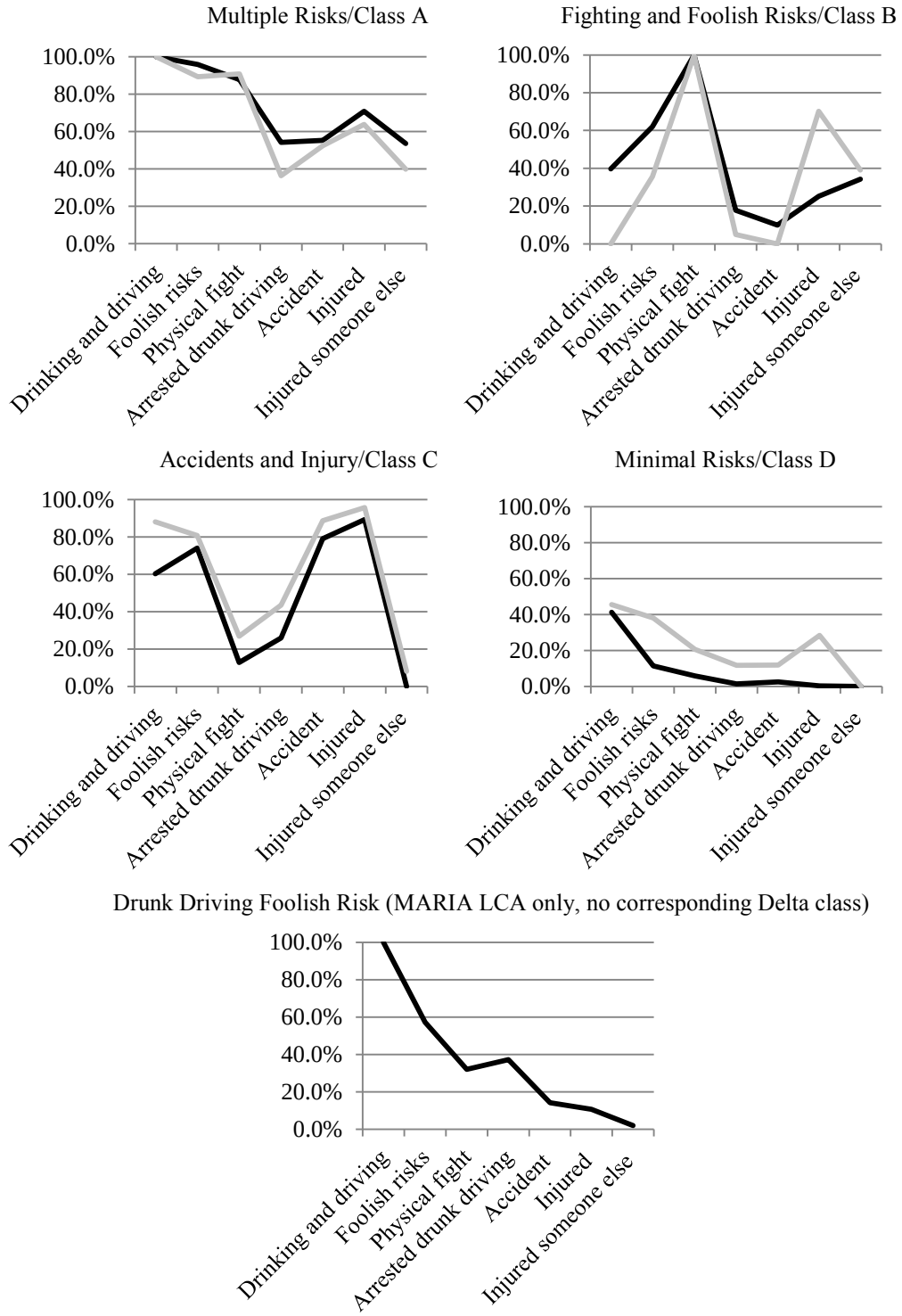
replication using the Delta Project dataset (n=250), a four-class solution best fit the data (AIC: 2021.48; ABIC: 2032.73; BLRT: p=0.03; see Table 14). The range of quality of classification for the Delta classes was 0.89 to 0.80.

Table 14. Optimum number of classes for observed indicators from MARIA and Delta samples

MARIA LCA			
Classes	AIC	ABIC	BLRT
2	5042.20	5063.61	0.00
3	4979.08	5011.91	0.00
4	4963.14	5007.38	0.00
5	**4950.12**	**5005.78**	**0.00**
6	4954.35	5021.43	1.00
DELTA LCA			
Classes	AIC	ABIC	BLRT
2	2045.95	2051.22	0.00
3	2025.66	2033.75	0.00
4	**2021.48**	**2032.73**	**0.03**
5	2024.30	2038.01	0.24

At first glance, one may conclude a four-class solution from the Delta Project indicates the replication model is not similar to that found within MARIA. However, model similarities become apparent when conditional item probabilities are plotted and compared (see Figure 4 and Table 14). With the exception of the class identified in MARIA by a high endorsement of drinking and driving and foolish risks, each of the classes in the LCA estimated using the Delta dataset had a corresponding class in the MARIA dataset (possible reasons for the absence of the *drunk driving foolish risk class* are related in the discussion section of this paper).

Figure 4. Plotted conditional item probabilities comparisons for MARIA (black line) and Delta (gray line)



Drunk Driving Foolish Risk (MARIA LCA only, no corresponding Delta class)

Table 15. Conditional item probabilities of the MARIA (white) and Delta (gray) LCAs

Classes	Drinking and driving	Foolish risks	Physical fight	Arrested drunk driving	Accidents	Injured	Injured someone else
Multiple risks (n=134, 18.1%)	100.0%	95.8%	87.8%	54.2%	55.2%	70.8%	53.6%
Class A (n=51, 20.4%)	100.0%	89.3%	90.8%	36.4%	52.4%	63.8%	39.9%
Fighting foolish risks (n=24, 3.3%)	39.7%	62.0%	100.0%	17.7%	9.9%	25.1%	34.3%
Class B (n=21, 8.4%)	0.0%	35.6%	100.0%	4.9%	0.0%	70.2%	39.0%
Accidents and injury (n=34, 4.6%)	60.3%	74.0%	12.8%	25.9%	79.0%	89.3%	0.0%
Class C (n=103, 41.2%)	88.1%	80.8%	26.9%	43.5%	88.6%	95.7%	8.1%
Minimal risk (n=298, 40.4%)	41.3%	11.5%	5.9%	1.4%	2.6%	0.3%	0.0%
Class D (n=75, 30%)	45.5%	38.1%	20.6%	11.8%	12.0%	28.5%	0.0%
Drunk driving foolish risk (n=247, 33.5%)	100.0%	57.3%	32.0%	37.2%	14.2%	10.7%	2.0%
Class ---*	---	---	---	---	---	---	---

*A class comparable to the MARIA LCA drunk driving foolish risk class did not emerge from the Delta sample.

Classes Comparisons

The MARIA *multiple risks class* and *Class A* from Delta Project possess similar conditional item probabilities, with the largest difference being that arrests for drunk driving were higher among MARIA participants. The *fighting and foolish risk class* from MARIA and *Class B* from Delta also possess similar conditional item probabilities, with the largest difference being that Delta participants were more likely to have experienced an injury while drinking. The profiles for the MARIA *accidents and injury class* and *Class C* from Delta are also similar, with the largest difference being that Delta participants were more likely to report drinking and driving after three drinks. Lastly, the MARIA *minimal risk class* and *Class D* from Delta shared similar profiles, with the

largest difference being for Delta participants who were more likely than MARIA participants to have experienced an injury while drinking.

Given the similarities among the classes from each dataset, in the remainder of this paper, the classes from both datasets are referred to as: *multiple risks, fighting and foolish risks, accidents and injury, and minimal risk*.

Covariates

Covariates were also estimated for the Delta Project LCA, with the *minimal risks class* used as the reference group (see Table 15), as was done in the MARIA LCA paper. Mentioned in the methods section, the race covariates entered into the model for the original MARIA LCA were yes/no Hispanic and yes/no Black variables. To allow the two models to more closely approximate one another, the MARIA LCA was rerun in the present project using yes/no White as the race covariate. The race covariate used for the Delta replication model was also yes/no White. The result of this exchange for the MARIA LCA model was that history of injury care, which was not a significant covariate in the original MARIA LCA *fighting and foolish risk class* (p=0.06), was significant (p=0.03) in the current replication. No other changes in significance of covariates occurred in the revised MARIA LCA model.

Examining the covariates for the Delta LCA, there were no significant predictors of membership in the *multiple risks* or the *fighting and foolish risk classes*. Causal attribution predicted membership for the Delta LCA *accidents and injury* class. Comparing significant covariates in the MARIA and Delta models, causal attribution predicted membership in both the MARIA and the Delta *accidents and injury* classes. A

further similarity is that the covariates of causal attribution, gender, and race did not significantly predict class membership for the *fighting and foolish risk classes*. What was not similar was that history of injury care in the *fighting and foolish risk* class was significant in the MARIA LCA but not in the Delta LCA. Also not similar was that all covariates significantly predicted membership in the MARIA LCA *multiple risks class* while none predicted membership in the Delta Project LCA *multiple risks class*.

Table 16. Predictors of class membership for MARIA (white) and Delta (gray; comparison group minimal risk class) *

Class	Effect	Estimate ǂ	S.E.	*p*
Multiple risks				
	Previous ED/hospital treatment for injury	1.19	0.27	0.00
	Causal attribution	1.36	0.28	0.00
	Male	1.28	0.41	0.00
	White	1.23	0.27	0.00
	History of injury care	-0.01	0.49	0.98
	Causal attribution	0.34	0.51	0.51
	Male	1.52	0.87	0.08
	White	0.73	0.50	0.15
Fighting and foolish risks				
	Previous ED/hospital treatment for injury	1.04	0.49	0.03
	Causal attribution	0.37	0.44	0.40
	Male	0.67	0.64	0.29
	White	0.30	0.46	0.51
	History of injury care	-0.10	0.63	0.88
	Causal attribution	-0.28	0.63	0.66
	Male	0.24	0.83	0.78
	White	-0.82	0.63	0.19
Accidents and injury				
	Previous ED/hospital treatment for injury	0.71	0.46	0.12
	Causal attribution	1.82	0.49	0.00
	Male	0.19	0.55	0.73
	White	0.24	0.46	0.60
	History of injury care	-0.47	0.42	0.26
	Causal attribution	1.26	0.49	0.01
	Male	0.17	0.53	0.74
	White	0.63	0.44	0.15

* The MARIA LCA drunk driving foolish risk class is not shown in this table.
ǂ This estimate is an unstandardized regression coefficient. A significant estimate indicates the covariate is associated with membership in the class.

Distal Outcomes

Distal outcomes were also calculated for the Delta LCA (see Table 16). There were no significant increases in PDA for any of the Delta classes. Among Delta

participants, the largest significant reductions in PDHD were for the *accidents and injury class*, which reduced its use by 30 percent from baseline to 12 months, with a d of 0.50. The largest significant decreases in average volume consumed at six and 12 months for Delta participants were for members of the *multiple risks class* who reduced their intake by 14.21 and 14.64 ounces, with ds of 0.82 and 0.73, respectively. Comparing MARIA and Delta Project outcomes, the *multiple risks* and the *accidents and injury classes* experienced the largest improvements in use, the *fighting and foolish risk classes* experienced the least amount of change, and the *minimal risks classes* experienced relatively small changes.

Table 17. Distal outcomes for MARIA (white) and Delta (gray)*ǂ

	Mean			Changes in Mean			d of change		
	Base MARIA N=737 Delta N=250	6 months MARIA N=511 Delta N=157	12 months MARIA N=420 Delta N=122	Base-6mo MARIA n=505 Delta n=157	6-12mo MARIA n=414 Delta n=105	Base–12mo MARIA n=419 Delta n=122	Base-6mo	6 - 12mo	Base–12mo
Percent days abstinent									
Multiple risks	52%	71%	71%	**18%**	0%	**19%**	0.46	0.01	0.47
Fighting foolish risks	66%	80%	77%	13%	-2%	11%	0.53	-0.05	0.35
Accidents and injury	62%	82%	80%	**20%**	**-2%**	18%	0.53	-0.05	0.44
Minimal risk	74%	81%	77%	**7%**	**-4%**	3%	0.10	-0.13	0.04
Multiple risks	54%	60%	59%	6%	-1%	5%	-0.13	0.01	-0.13
Fighting foolish risks	64%	56%	47%	-7%	-9%	-16%	0.69	0.70	1.68
Accidents and injury	60%	51%	49%	-8%	-2%	-11%	0.16	0.04	0.22
Minimal risk	55%	45%	52%	-10%	7%	-3%	0.21	-0.12	0.07
Percent days heavy drinking									
Multiple risks	70%	62	60%	-8%	-2%	-10%	0.16	0.03	0.17
Fighting foolish risks	56%	64%	41%	8%	-23%	-15%	-0.12	0.29	0.23
Accidents and injury	66%	46%	58%	-20%	12%	-9%	0.32	-0.14	0.13
Minimal risk	58%	40%	36%	**-19%**	-4%	**-22%**	0.31	0.05	0.37
Multiple risks	55%	30%	30%	-25%	0%	-25%	0.47	0.00	0.47
Fighting foolish risks	57%	43%	29%	-14%	-4%	-28%	1.01	0.83	2.14
Accidents and injury	52%	22%	22%	-30%	0%	**-30%**	0.50	0.00	0.50
Minimal risk	52%	25%	24%	-27%	-1%	**-28%**	0.48	0.00	0.51
Average volume consumed per week									
Multiple risks	28.10	13.90	14.00	**-14.20**	0.10	**-14.10**	0.43	0.00	0.43
Fighting foolish risks	13.40	10.80	10.60	-2.60	-0.20	-2.80	0.09	0.00	0.09
Accidents and injury	20.00	7.10	7.40	-12.90	0.30	-12.60	0.50	-0.01	0.50
Minimal risk	9.70	6.50	7.50	-3.20	**1.00**	-2.20	0.18	-0.05	0.11
Multiple risks	20.00	5.79	5.36	**-14.21**	-0.43	**-14.64**	0.82	0.02	0.73
Fighting foolish risks	16.27	10.80	12.96	-5.48	2.16	-3.32	0.96	-0.25	0.50
Accidents and injury	15.19	2.78	4.16	**-12.41**	1.38	**-11.03**	0.85	-0.10	0.64
Minimal risk	17.65	5.05	6.17	**-12.61**	1.13	**-11.48**	0.66	-0.05	0.54

*Bolded values represent change $p<0.05$

ǂ The MARIA drunk driving foolish risk class is not shown in this Table.

DISCUSSION AND LIMITATIONS

Model Similarities

The major similarities between the MARIA five-class solution and the Delta four-class solution can be observed when comparing conditional item probabilities, particularly the plotted probabilities. Similarities can also be viewed when comparing some covariates and distal drinking outcomes. In specific terms, the *multiple risks* and the *accidents and injury classes* appear to have made the greatest improvements in alcohol use while the *fighting and foolish risk* and *minimal risk classes* improved less.

Improvements in drinking for the *multiple risk classes* appear to agree with findings from Field and Caetano (2010) and Field et al. (In press) that demonstrated dependent participants fare better for alcohol use outcomes following discharge from a trauma center. Given that the *multiple risks classes* in the samples had higher levels of alcohol use at baseline in conjunction with their high probabilities for consequences and risks of alcohol misuse, these classes possibly approximate the use patterns and alcohol problems associated with symptoms of dependence. Therefore, the *multiple risks classes* in both samples could be experiencing similar changes as those documented in previous literature among dependent users (Field & Caetano, 2010; Field, et al., In press).

For improvements in the *accidents and injury class*, as was observed in the original MARIA LCA paper, the Delta participants also had a history of alcohol-related injuries but not injuries for which they have sought care in a medical setting. This absence of previous injury care in a medical facility along with their current alcohol-related injury care could be motivating some degree of change among members of this

class. Future research should explore this connection, and if verified, clinical practice may benefit from highlighting the connection between alcohol use and injury.

Further, in both models, the *fighting and foolish risk* and *minimal risk classes* experienced the smallest reductions. The absence of change in the *fighting and foolish risk classes* in both datasets runs counter to findings from Watt and colleagues (2008) that demonstrated those who commit violent offenses have greater improvements following SBI. Further research should explore this small degree of improvement. Also requiring future research is the small amount of change among *minimal risk classes*. In both the MARIA and Delta datasets, the *minimal risk classes* reported the lowest baseline levels of alcohol use. This result is consistent with findings from the Delta main outcomes study that demonstrated little improvement among lower level drinkers (Soderstrom, et al., 2007).

Federal guidelines encourage that brief interventions be delivered to those with risky or less than risky alcohol use while referral to treatment should be the focus of interactions with those who drink at higher levels (Higgins-Biddle, et al., 2009; SAMHSA, 2011). Some research indicates that heavier drinkers respond less to SBI (Gentilello, et al., 1999); however, the approach of primarily referring heavier drinkers to treatment is not conclusively supported in the literature, as has been demonstrated for dependent and heavy drinking populations' positive response to brief intervention (Field & Caetano, 2010; Monti, et al., 2009). Together, these facts may point to the possibility that drinking improvements following injury and SBI could have some association with more than just level of alcohol use, but also, that changes are related to the multiple

behaviors contributing to alcohol-related injury. LCA and other mixture modeling statistical techniques seem to be appropriate to draw out these complexities. Therefore, because subclasses and differential levels of change have been identified in two samples, future research would benefit from further exploring the similarities between models.

Model Differences

Differences between the models indicate possible limitations and warrant discussion. The Delta model does not have a *drunk driving foolish risk class* that is comparable to MARIA. State-level drinking and driving patterns may help to explain this difference. In Texas (where MARIA was conducted), drinking and driving-related fatalities rank fifth highest and alcohol-related crashes rank sixth highest in the nation. In Maryland (where Delta was conducted), alcohol-related traffic fatalities are ranked 35th highest and alcohol-related crashes are 36th highest in the nation (National Highway Traffic Safety Administration, 2008a). It is possible that because of these higher levels of drinking and driving in Texas, a *drunk driving foolish risk class* did not emerge from the Delta sample. These regional differences in drinking and driving could also help to explain why the MARIA *multiple risks class* reported higher levels of DUI than those in the Delta *multiple risks class*.

In addition to differences based on region, the absence of a *drunk driving foolish risk class* in Delta could also be attributed to the racial/ethnic make-up of the samples. The MARIA project contained a number of Hispanic individuals, and Hispanics have been observed to drink and drive at disproportionately higher rates in the United States compared to other race/ethnicities (Romano, Voas, & Lacey, 2010). Therefore, it seems

reasonable that a *drunk driving class* would emerge from the Texas sample but not from Maryland. In fact, as was noted in the results section, the MARIA sample at baseline showed possible binge use patterns at higher rates than the Delta sample. Data from the 2009 National Survey on Drug Use and Health show binge alcohol use as highest among Hispanics compared to all other races and/or ethnicities (National Survey on Drug Use and Health, 2009). Together, this possible baseline difference in binge use and the absence of the *drinking and driving foolish risk class* both point to the possibility of model differences based on drinking patterns among individual racial/ethnic groups. However, further research would be beneficial to substantiate or disprove these possible explanations for model differences.

Related to the differences in the number of classes found across the two studies is the Delta sample endorsed higher levels of injury than MARIA within the *fighting and foolish risk, accidents and injury,* and *minimal risk classes*. This pattern may also be explained by geographic differences. The trauma center where patients were recruited for the Delta trial is located in the city of Baltimore, a city ranked as one of the top 10 most dangerous and violent in the nation (Federal Bureau of Investigation [FBI], 2010a; Giuffo, 2011). In contrast, the city of Dallas, where MARIA participants were recruited, has less violent crime (FBI, 2010a). According to the 2010 FBI Uniform Crime Report data, the per capita rate of violent crimes is more than two times higher in Baltimore than Dallas—with aggravated assaults (a subcategory of violent crime) being nearly three times higher in Baltimore than Dallas (FBI, 2010b). Given this distinction, Delta participants could be more likely to have experienced alcohol-related injuries stemming

from violence than those in MARIA. This possible explanation of differences should be investigated further (As a note, both studies collected information regarding whether participants' current injuries and past injuries were intentional or unintentional. However, the timeframes and manners in which these data were categorized/collapsed were sufficiently different to not allow clear statistical or descriptive comparisons between studies).

Differences between the models also emerged in terms of significant covariates. The most marked difference was that all the covariates added to the models predicted membership in the MARIA *multiple risks class* but not for Delta. One possible explanation for this difference could be the fact that the investigators in Delta Project did not recruit those with severe alcohol problems (Soderstrom, et al., 2007) while MARIA included a number of dependent drinkers. Specifically, the MARIA *multiple risks class* had a greater proportion of dependent drinkers (χ^2=88.32, df=4, p<0.001, results not shown) than the other four classes in the model. Further, the MARIA *multiple risks class* reported at baseline more days heavy drinking (M=0.72) than the other classes in the model (M=0.60, t= -3.01, df=207.4, p=0.003, results not shown). Given the fact that history of injury care (Sims, et al., 1989; Smith, et al., 1992), injuries caused by alcohol misuse (CDC, 2010), and being a White male (Grant et al., 2004) have been observed to have an association with increased levels of alcohol use, and those in the MARIA multiple risks had a greater proportion of dependent and heavy drinkers, significant covariate relationships could have been more easily detected in the MARIA data than Delta. That is to say, by excluding more severe levels of alcohol use in the Delta Project,

significant covariate relationships were not manifest. In spite of the reasons why dissimilarities in covariates emerged, this difference in results impacts the conclusion drawn in the MARIA LCA paper that the *multiple risks class* could possibly be more easily identified because of the significant covariates predicting class membership. This does not appear to be the case for the Delta multiple risk class. Further research should explore these differences.

There was also a difference for the history of injury care covariate between the MARIA and Delta *fighting and foolish risk classes*. The specific difference was that the history of injury care significantly predicted class membership for MARIA *fighting and foolish risk class* but not for Delta. As was mentioned, in the original MARIA LCA *fighting and foolish risk class* from paper one of this dissertation, history of injury care was not significant (p=0.06). However, with the exchange of race covariates from yes/no Hispanic and yes/no Black to yes/no White, the *p*-value for this covariate in this class became significant (p=0.03). Therefore, future analyses should take into consideration the influence of race within similar LCA models as it appears that the variance accounted for through the inclusion of White covariate instead of Hispanic and Black has a somewhat different impact on the model.

A further difference between the two LCA models was the absence of significant increases in abstinence (PDA) for Delta classes while MARIA participants in the *multiple risks, accidents and injury, and minimal risk classes* showed increases. This difference could be associated with MARIA's (1) higher number of Hispanics and (2) the possibility of higher levels of baseline binge use (i.e., higher levels of baseline PDA along with

higher levels of heavy drinking indicate possible binge use). As noted above, Hispanics have the highest levels of binge use in the country (National Survey on Drug Use and Health, 2009). It may be the case that the significant increases in PDA for MARIA and not Delta are related to findings from the original MARIA study showing the intervention was efficacious in reducing drinking among Hispanic but not White or Black patients (Field, et al., 2012). That is to say, increases in PDA for MARIA may reflect improvements in binge use among Hispanics. However, such a possibility requires further investigation.

CONCLUSION

This secondary analysis lends support to the concept that traumatically injured patients who receive SBI can be classified based on injury-related consequences and risks of alcohol misuse into similar subgroups within separate trauma centers. This analysis further demonstrated that certain classes of individuals, particularly the *multiple risks and consequences* and the *accidents and injury classes*, experience some of the greatest improvements following discharge. Future should be directed toward additional verification of the findings from this study, and research should further examine the differences noted and develop methods to test the findings within practice settings. For instance, using patient data management platforms, clinicians and researchers could develop strategies and tools to enable providers to identify individuals who are included in these subclasses. Electronic record systems likely already contain many of the variables included in the present analysis and could be used to capture the consequences of alcohol-related risks included in these analyses. With such tools created, those likely

to change could more easily be targeted to receive more costly brief intervention services to maximize service delivery outcomes. Such a targeting approach would allow providers to develop other or deliver less intense and expensive service strategies intended for those who may be likely to experience less change. Such a targeted approach to SBI also has the potential to improve outcomes for injured patients and reduce unnecessary costs of delivering more costly services to those unlikely to reduce use.

CHAPTER V: Discussion and Conclusion

SUMMARY OF BACKGROUND AND FINDINGS WITHIN A PUBLIC HEALTH SERVICES CONTEXT

Screening injured patients for alcohol misuse and providing brief interventions to those who are positive is a standard of care for Level-1 trauma centers in the United States. As such, SBI constitutes a large scale response to alcohol misuse and injury-related risk behaviors delivered by health care providers, including surgeons, nurses, social workers, and other health care professionals. Given the widespread use of SBI with injured patients, discussing this dissertation within a public health services framework helps to place it within a larger health care context, and more importantly, the framework facilitates a synthesis of the findings geared toward future steps for SBI research, individual-level practice, and macro-level practice. The public health services framework used in this chapter focuses on: (1) the population of injured patients and their needs resulting from alcohol misuse and related risk behaviors, (2) health services delivered to the population, and (3) targeted improvements for health and behavioral health outcomes (Oleske, 2009).

Population of Interest and Health Service Needs

The population of interest (Oleske, 2009; Shapiro, 1998) in this dissertation is individuals in the United States who misuse alcohol and engage in risk behaviors that result in injury and subsequent care in Level-1 trauma centers. Risky alcohol use is the primary predictor of injury in the country and is a major contributor to emergency room use and trauma center admissions. Two closely associated behaviors that predict

traumatic injury and seeking care are drinking and driving and alcohol-related violence. Given this close association between alcohol misuse and behaviors that precede injury care, it is important that those who misuse receive help to reduce drinking and avoid risk behaviors.

Unfortunately most people in the nation who are in need of alcohol treatment do not receive that care. Furthermore, although lack of access to specialty alcohol treatment impacts people in all socio-demographic groups, lack of access is particularly evident among racial/ethnic minorities. Though most individuals do not seek alcohol misuse treatment services on their own, patients' acute health care needs (Oleske, 2009) resulting from traumatic injuries drives them into Level-1 trauma centers where they are screened and receive intervention services. These services are designed to identify potential alcohol use problems and provide help to those in need. Therefore, health care providers in trauma settings; including surgeons, nurses, social workers, and psychologists; play an important role in screening injured patients for alcohol misuse and delivering brief interventions to target alcohol misuse and injury-related risk behaviors.

Utilization of Health Care Service

Health care services utilization is critical in improving population health because these services delivered by providers are the mechanism intended to positively impact the population's health and behavioral health (Oleske, 2009). A central point of analysis is whether the health care utilization is appropriate or not (Lavis & Anderson, 1996; Oleske, 2009). Appropriateness can be examined from two perspectives. The first perspective examines whether or not the service itself is appropriate for the population. The second

perspective examines whether or not the setting in which the service is delivered is appropriate (Lavis & Anderson, 1996; Oleske, 2009).

As discussed in chapter one of this dissertation, the efficacy of SBI for injured patient populations has mixed research findings. Specifically, brief interventions have been shown to be effective in reducing use, injury recidivism, and drinking and driving events for some patients. For others, the efficacy of these outcomes is not clear. In addition to the mixed clinical evidence for brief intervention, policy level supports are also somewhat problematic. Namely, although brief alcohol intervention has been included as an accreditation standard for Level-1 trauma centers (i.e., SBI must be carried out as a standard of care), the majority of states do not reimburse providers for SBI, and in half of U.S. states, insurers may not reimburse the costs for care of injuries that result from alcohol intoxication.

Unclear empirical support for the efficacy of SBI for alcohol and possible reimbursement challenges may call into question the appropriateness of SBI utilization for alcohol misuse for all patients in Level-1 trauma centers. First, whether SBI is appropriate for all trauma patients is a concern because providers are mandated to provide a health care service based on mixed research findings regarding its effectiveness for all patients. Second, because (1) trauma care settings are generally not profitable; (2) SBI is typically not reimbursed in trauma settings, and (3) patients with alcohol-related injuries may be denied reimbursement for care, the appropriateness of SBI delivery in Level-1 trauma departments comes into question because of the financial burden it could add to this health care setting.

Given these questions regarding the appropriateness of the universal delivery of brief interventions for all injured patients who misuse alcohol in Level-1 trauma centers, examining which SBI recipients experience the greatest change following discharge from the hospital could help providers target or prioritize intervention delivery to those most likely to make the greatest change. Targeting services has the potential to address the appropriateness of delivery of SBI to all patients by identifying the groups who will experience the largest improvements while at the same time directing alternative services to those other groups who may experience less improvement. In the same vein, targeting services would also help address the appropriateness of SBI delivery in trauma centers by helping to direct these services to those who will experience the most improvements and developing other or directing less costly services to those who may improve less. Targeting specific health care services to patients who will experience the greatest improvements is a common approach within the health care system, such as delivering particular types of treatment for specific types of cancer or triaging patients in emergency settings so as to identify those who are in need of the most immediate care.

The research literature makes it evident that those who misuse alcohol and receive care for traumatic injury are frequently drinking at risk levels, drinking and driving, and are involved in alcohol-related violence. Research also has shown that response to SBI may be associated with gender, ethnicity (i.e., Hispanics may respond to a higher degree than non-Hispanic patients), severity of alcohol problems, and those who attribute their injuries to alcohol use compared to those who do not. However, it is not clear how these individual factors come together to influence changes in drinking following discharge

from the trauma center. This dissertation addressed three research aims by employing mixture modeling to identify subgroups of individuals from among intervention recipients. With the identified subclasses, this dissertation then described which subgroups experienced the greatest improvements in alcohol misuse and injury-related consequences and risks of alcohol misuse across time.

Health and Behavioral Health Outcomes: Summary of Aims and Findings

The first research aim in this dissertation identified subclasses of injured patients who received a brief alcohol intervention in a Level-1 trauma center and which classes experienced the greatest improvements. Latent class analysis (LCA) was used to identify probabilistic patient profiles or "classes" based on past injury-related risk behaviors. Demographic characteristics, injury history, and patient beliefs about the relation of their alcohol use to the injury event were used to determine individuals' membership in the defined classes. Level of improvement was measured by which injury-related risk profile experienced the greatest reductions in alcohol use.

The results of this analysis demonstrated that five subclasses of participants existed among intervention participants based on lifetime consequences and risks related to alcohol misuse. These classes of study participants were labeled: (1) *multiple risks and consequences*, (2) *drunk driving foolish risk*, (3) *fighting and foolish risks*, (4) *accidents and injury*, and (5) *minimal risk and consequences*. Those that experienced the largest improvement in drinking after discharge were the *multiple risks and consequences* and the *accidents and injury classes*. The class of individuals that reported some of the least change following discharge was the *fighting and foolish risk class*. Causal attribution

predicted membership in each of the classes except for the *fighting and foolish risk class*. This finding potentially supports previous research showing that improvements in alcohol use are influenced by individuals making a connection between their drinking and their injury.

The second research aim of this dissertation analyzed the longitudinal injury-related risk behavior profile changes experienced by patients in the year following the receipt of a brief alcohol intervention and discharge from a trauma center. Latent transition analysis (LTA) was used to model the transitions that patients experienced from their baseline injury-related risk subclasses into other subclasses across time. The profiles established for the LTA were based on individuals' risks and consequences (1) reported at baseline for the year before admission to the trauma center and (2) reported at 12 months for the year after discharge.

Results from the LTA found that there were four classes of patients at each time point, and following discharge from the trauma center, most patients transitioned from classes characterized by higher risks and consequences into classes with lower levels of risks and consequences. Notwithstanding these positive transitions, some of the lower risk classes at time-two maintained somewhat high levels of drinking and driving. There was also a subset of individuals whose risks and consequences behaviors either stayed the same or worsened in the year following discharge.

The third and final research aim of this dissertation partially replicated the LCA model from research aim one using a second dataset from a similar brief alcohol intervention trial conducted in another separate Level-1 trauma center. The purpose of

replicating findings from research aim one using a separate dataset was to determine whether the established LCA model could be supported in a second population. The replication of research studies is one manner to examine the objectivity, accuracy, and generalizability of results.

The results of this analysis showed that, with the exception of the *drunk and driving and foolish class*, each of the other latent classes identified in the paper one LCA had a similar profile that emerged in the second dataset analyzed. Model similarities were most apparent when comparing the plotted conditional item probabilities. The distal drinking outcomes that were estimated showed a trend of similarities in drinking improvements for the LCAs from paper one and the replication. These similarities included the *multiple risks* and *accidents and injury classes* making the largest improvements in drinking behaviors. Further, the *fighting and foolish risk and minimal risk classes* experienced the smallest improvements. Differences were also noted between paper one and the replication for the covariates that predicted class membership of the multiple risks class.

In summary, latent subclasses of patients who received a brief intervention in a Level-1 trauma center were identified. Among these classes, those with high levels of risks and those who suffered injuries and accidents while they were drinking reported the greatest improvements in alcohol use and behavioral profiles across time. Other classes, however, improved to a lesser extent. As a result, the information in this dissertation provides preliminary evidence regarding which patients may be targeted to receive SBI and which patients may benefit from other types of services.

IMPLICATIONS FOR PUBLIC HEALTH SERVICES AND PROVIDERS

The three papers in this dissertation have possible implications for SBI research, direct practice, and macro practice—potentially helping to increase the appropriateness of brief intervention delivery for injured patients in Level-1 trauma centers. However, in spite of the fact that improvements among classes were to some degree consistent across analyses, this dissertation's results are insufficient to support actual clinical or policy implementation of patient classification and targeting brief interventions in Level-1 trauma centers. As discussed in each of the papers and summarized within the following research implications section, researchers still must answer a number of questions to establish a sufficient knowledge base to move forward with the possible implementation of targeting SBI. If questions that were outlined in the papers can be answered adequately, some level of patient classification for purposes of targeting interventions could be designed, tested, and implemented.

Implications for Future Research

In each analysis conducted in this dissertation project, at least one class emerged from each mixture analysis that was somewhat small in total number of participants. These small classes may indeed be real classifications, or they may be merely artifacts of the statistical solution. While this issue requires further analysis, there was some indication across the three papers that at least one of the small classes was not simply an artifact of the model solutions. In each of the three dissertation papers, a class emerged that was characterized with high conditional item probabilities for fighting and taking foolish risks while drinking. Therefore, this pattern provides an indication that a *fighting*

and foolish risk class of individuals exists among brief intervention recipients, despite its smaller number of members. Establishing analogous patterns would lend similar credibility to other latent classes consisting of smaller numbers of participants.

Notwithstanding these promising patterns supporting its existence, the *fighting and foolish risk class* was also the class that experienced some of the lowest amounts of change following discharge from the trauma center. Another consistent finding was that causal attribution did not significantly predict membership in this class. Because causal attribution appears to have some influence among individuals within most other classes and in previous research regarding improvement in drinking outcomes (Barnett, et al., 2010; Walton, et al., 2008), future research should examine whether highlighting causal attribution with these patients can enhance changes following discharge.

If emphasizing causal attribution did not prove to be effective for enhancing change, future research with the *fighting and foolish risk classes* and the *minimal risk classes* (both reporting little change following discharge) could examine whether less intense interventions, such as brief advice, could yield similar outcomes as those observed in this dissertation. Indeed, if the amount of change demonstrated among these classes is in reality the maximum that can be expected, then it stands to reason that testing if lower cost and less time intensive interventions could produce the same changes as a full brief intervention may be helpful. Such an approach could potentially increase the appropriateness of brief intervention by reducing costs and provider burden associated with brief intervention delivery to all trauma patients. It also could be the case that more intensive services are needed for the *fighting and foolish risk classes* and the

minimal risk classes. Delivering more intensive services may not reduce the immediate costs for SBI; however, alcohol misuse and injury-related behavior reductions achieved by more intensive services could have important clinical and financial influences in the long-term.

Aside from future studies that would focus on exploring and understanding the limited change among classes, potential research was also recommended to explain the absence of a *drunk driving and foolish risks class* and covariate differences noted in paper three of this dissertation. Paper three used Delta Project data to replicate findings from the paper one MARIA LCA. The hypothesized reason the *drunk driving foolish risk class* did not appear in the Delta LCA was that Texas (where MARIA was conducted) is a state with higher drinking and driving rates than Maryland (where Delta was conducted). It was also hypothesized that a *drunk driving foolish risk class* was absent in the Delta LCA because there was a greater number of Hispanic participants in the MARIA study, an ethnic group that drinks at disproportionately higher rates. A second difference noted between the MARIA LCA and Delta replication LCA was that all the covariates added to the model predicted membership in the MARIA LCA *multiple risks class* but not Delta. The hypothesized cause of this difference was the absence of heavy drinkers in the Delta data. Additional research would be required to explore this possibility.

A potentially valuable finding from the LTA model for further exploration is drinking and driving for patients post-discharge. Most participants in paper two were observed to transition from higher risk classes into classes with lower levels of alcohol-

related risks and consequences in the year after discharge. The exception to this positive finding was some of the lower risk classes had higher probabilities of drinking and driving. Future research should attempt to replicate this finding to further establish its credibility. If verified, additional research could examine the effects of an added drinking and driving component to existing intervention services in order to prevent or reduce future drunk driving episodes.

Future research may also examine how the findings of this dissertation (namely the classes and their corresponding levels of change post-discharge) could be tested in a trauma setting by using data housed in electronic medical record (EMR) systems. EMRs are information management systems that contain data about patients and patient care occurring at medical facilities. These systems have the capability to capture and retain patient responses to the questions upon which the measurement models in this dissertation were established (i.e., the seven SIP+6 indicators). Capturing data on a large sample of patients would make it possible to develop and test mechanisms to classify patients based on screening information. If the classes proved to be consistent with those identified in this dissertation project, these findings would provide further evidence that the classes are functional and could act as groupings by which patients could be assigned to different levels of intervention intensities, again potentially helping to increase the appropriateness of SBI in trauma centers.

Implications for Individual Practice

Adequate answers to these questions could constitute sufficient grounds for surgeons, nurses, social workers, and other health care providers involved in the delivery

of brief interventions to consider these sub-classifications in SBI planning and delivery. In particular, health care professionals could consider that while all patients experience some degree of change following interventions and discharge, the classes of participants that have multiple risks and the classes that are comprised of individuals who suffer from accidents and injuries are those that undergo some of the highest degrees of change compared to others. In addition to the change in alcohol consumption itself among the different classes identified, providers also could take into account the role that causal attribution may play in the alcohol consumption improvements occurring among the *accidents and injury class* members and explore how it might help other classes improve change.

Furthermore, for drinking outcomes, clinicians may take into account that it is the classes of patients that highly endorse fighting and foolish risk-taking while drinking and the classes with patients reporting few risks that experience some of the least change following interventions and discharge from the trauma center. The lack of positive change among the *fighting and foolish risk classes* runs counter to findings from Watt et al. (2008) that show those involved in violent offenses may experience significant improvements following the receipt of brief intervention. Likewise, it also may seem counter to federal recommendations (Higgins-Biddle, et al., 2009; SAMHSA, 2011) and previous research (Gentilello, et al., 1999) that the *minimal risks class* members (who reported low levels of alcohol use) would experience little change while those with higher levels of use (including dependence) experienced consistent and significant reductions in alcohol use. However, when taking into account that Field and Caetano

(2010) found a significant interaction effect for dependent patients reducing alcohol misuse, these findings and those from this dissertation collectively may indicate that improvements following discharge have a stronger relationship with the *combination* of alcohol misuse and misuse-related behaviors than alcohol use alone. That is to say, since alcohol dependence is a composite of alcohol use and related behaviors, and because the items employed in the measurement model of this dissertation also combined alcohol use and related behaviors, these findings could demonstrate that change in alcohol use following injury is better described by drinking combined with other behaviors than just alcohol consumption alone.

Given the association between alcohol use and behaviors that predict injury, it was pertinent to also examine the long-term changes among subclasses for alcohol misuse consequences and risks that predict injury care. Trends in improvements were observed in the analysis of latent transitions (paper two) for the injury-related consequences and risks of alcohol misuse classes. The classes identified at baseline as being comprised of multiple risks and high risks for accidents and injuring self were those who reported some of the largest transitions and therefore greatest changes into other classes post-discharge with considerably lower probabilities for endorsing risk behaviors and consequences. Surgeons, nurses, social workers, and other health care providers may therefore pay particular attention to ensure patients with these profiles receive the full brief intervention services in light of the probability that they will experience the most change following discharge, again helping to increase appropriateness of interventions. However, as was noted for future research, probabilities

of drinking and driving were somewhat higher in the lower risk classes post-discharge than at baseline. If these rates of drinking and driving can be verified, practitioners must incorporate and emphasize drinking and driving with patients to prevent future episodes.

Implications for Macro Practice

If classification of patients was deemed accurate, feasible, practical, and successful, this dissertation suggests three possible macro-level implications. The first implication is the American College of Surgeons could add measures such as were used for this dissertation's LCA and LTA (the seven SIP+6 indicators) along with the covariates and distal measures to the National Trauma Registry Databank. Their inclusion would increase the sample size from which to establish future research, and nationally representative models would demonstrate high standards and commitment from the College to providing evidence-based behavioral health services to all patients.

The second macro-level implication of this dissertation is the possibility of requiring a drinking and driving component as part of brief intervention. If future research buttresses the findings of the LTA paper, the American College of Surgeons might be prompted to require patients who screen positive for alcohol misuse to receive face-to-face counseling regarding drinking and driving. The importance of drinking and driving prevention is grounded in the high numbers of people who die each year either as perpetrators or victims. Such an evidence-based initiative would likely receive much support from the drinking and driving prevention community and could have the potential to make a meaningful reduction in drunk driving episodes and crashes.

The third and final macro-level implication based on this dissertation's findings is with respect to costs associated with SBI and care for those who are injured. If these results can be further established as feasible and practical in clinical practice, such evidence would indicate that a targeting approach may be a superior method of delivering brief interventions. If interventions were targeted to those who will experience the greatest change following discharge, providers could develop or deliver other interventions to produce more change or less costly and time intensive interventions. The result therefore could be a cost savings to trauma centers in both time and staff costs for doctors, nurses, social workers, and other providers who carrying out the functions associated with brief interventions—without, most importantly—compromising the long-term results for improvements to drinking and risk behaviors. While these savings alone would not rescue trauma centers from not being typically being financially profitable, such a cost savings could reduce some of the burden of care for providers and patients.

CONCLUSION

Alcohol misuse in the United States has serious societal and individual repercussions. Most people who misuse alcohol do not seek appropriate treatment to help reduce use and avoid consequences of misuse. Because alcohol misuse and alcohol-related risk behaviors often result in injury, health care professionals; including doctors, nurses, and social workers; have an excellent opportunity to screen injured patients for misuse patterns and provide brief interventions for those who need help. However, research indicates that brief alcohol interventions are not equally effective for all injured

patients. Furthermore, SBI is a service that is not reimbursed in most states. Therefore, this dissertation used mixture modeling to identify subclasses of traumatically injured patients based on their self-reported histories of injury-related consequences and risks of alcohol misuse before and after injury, admission, and intervention. The classes that reported greatest amount of change following interventions and discharge from the trauma center were those with profiles that contained high probabilities of multiple consequences and risks and those with histories of alcohol-related accidents and injuries that currently associated their injury with alcohol use. Those classes that experienced the least amount of change had profiles that either consisted of participating in fights and foolish risks while drinking or those that reported histories comprised of low probabilities of risks or consequences of alcohol misuse. Altogether, these results provide tentative evidence for targeting intervention services to those individuals who will experience the greatest improvement for alcohol use. Further research is needed to verify for whom these services can be most effective in order to more effectively target SBI, increase cost savings, and improve the health and behavioral health outcomes for those who misuse alcohol and suffer injury.

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